SCIENCE

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FRIDAY, NOVEMBER 23, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

THE fourteenth annual convention of the Association of American Agricultural Colleges and Experiment Stations was held at New Haven and Middletown, Connecticut, November 13th–15th. Most of the sessions were held in the assembly room of the Sheffield Scientific School of Yale University, where the delegates had the pleasure of meeting President Hadley, who delivered a short address. Professor W. H. Brewer, of the Sheffield Scientific School, and Dr. E. H. Jenkins, of the Connecticut Experiment Station, actively promoted the comfort of the delegates and the business of the convention. The Association went to Connecticut this year especially to celebrate the twenty-fifth anniversary of the founding of the Connecticut State Agricultural Experiment Station. The colleges and stations of all sections of the country were represented.

The report of the Executive Committee pointed out that Congress had recognized the importance of the land-grant colleges to the country in a notable way during the past year by providing that when the proceeds of the sale of public lands were insufficient to meet the annual appropriations for these institutions, the deficiency should be met by direct appropriations from the National Treasury.

President J. E. Stubbs, of the University of Nevada, presided at the general sessions and delivered the president's annual address. He took strong ground regarding the fundamental necessity for the direct and indirect teaching of sound moral principles in our public educational institutions of all grades. "It is character and not intelligence that determines the historical development of nations. It is character and not intelligence that distinguishes one individual from another and contributes to social well-being. The morality of the race, together with its strength and vigor, must be the principal object of education; all else is secondary."

A carefully prepared and eloquent address on the career of the late Senator Justin S. Morrill, of Vermont, was delivered by President G. W. Atherton, of the Pennsylvania State College. President Atherton's close association with Senator Morrill for many years and his intimate familiarity with the history of the movement for the establishment of colleges and agricultural experiment stations under national auspices enabled him to treat this subject in a very thorough and satisfactory manner, so that his address will have a permanent historical value.

Dr. Bernard Dyer, of London, England, as the representative of the Lawes Agricultural Trust, delivered the biennial course of lectures provided for in that Trust. In these he gave a *résumé* of the investigations at the Rothamsted Experiment Station during the past fifty years with different kinds of fertilizers on wheat, pointing out especially the effects of different systems of manuring on the amount and availability of the fertilizing constituents in the soils experimented with. It is expected that a detailed account of this work will be published later by the Department of Agriculture. Besides resolutions of thanks to Dr. Dyer, the Association adopted a memorial showing its high appreciation of the life and work of Sir John Bennet Lawes and his associates at the Rothamsted Station.

One day was spent at Middletown, where the Association was most cordially received and hospitably entertained by Wesleyan University. The delegates were also given a reception at the residence of Professor W. O. Atwater and had the opportunity of seeing the Atwater-Rosa respiration calorimeter in operation. At a meeting held in the University chapel, Dr. W. H. Jordan, Director of the New York State Experiment Station, gave a historical address on the American Agricultural Experiment Stations. Besides reviewing the rapid growth of this great enterprise from its beginning at Middletown twenty-five years ago and pointing out the great scientific and practical results which it has already achieved, Dr. Jordan strongly urged that the stations should use every effort to put their work more fully on a high scientific level and devote themselves very largely to original investigations.

He was followed by Professor W. O. Atwater, who gave a number of interesting details regarding the establishment of the Connecticut Station as the first State Station in this country and showed that the influence of this station had been very great in shaping the organization and work of other stations. He also pointed out that a relatively large number of men, now prominently identified with the experiment station enterprise in this country, had been trained at Yale University, Wesleyan University, and in connection with the work of the Connecticut Experiment Stations.

In the Section of Agriculture and Chemistry much attention was naturally given to discussions of investigations on tobacco, the Connecticut State Station being engaged in important work in this line. Dr. E. H. Jenkins, Director of the Connecticut State Station, read a carefully prepared paper

on methods of experimenting with cigar-wrapper leaf tobacco, in which he showed that one important result of the experiments of the Connecticut Station has been the confirmation of the results obtained by the investigations under direction of Professor Milton Whitney, Chief of the Division of Soils of the Department of Agriculture, indicating that the character of the tobacco leaf is in a great degree dependent on the physical character of the soil in which the plant is grown. Professor M. A. Scovell, Director of the Kentucky Station, read a paper on the methods of growing and curing white Burley tobacco. In discussing these papers Professor Whitney brought out the interesting fact that, with scientific management of the crop, tobacco almost identical with that grown in Sumatra can be produced in the Connecticut Valley. Among other papers read in this section were those on tests in feeding dairy herds, by Professor C. S. Phelps, of the Connecticut Storrs Station; cooperative field experiments, by Director E. B. Voorhees, of the New Jersey Stations; on the raising of sugar beets as a new and profitable industry in this country, by Director I. P. Roberts, of the Cornell University Experiment Station; and on available energy in foods, by Professor W. O. Atwater.

The report of the section on Horticulture and Botany, presented by Professor S. A. Beach, of the New York State Station, showed that there had recently been a great growth of interest in the subject of plant breeding and that studies in this direction were being undertaken by both botanists and horticulturists. There is a marked tendency to devote relatively less time to systematic botany and give much more consideration than formerly to problems in plant physiology. The testing of varieties still occupies a large place in the work of the stations, but it is being supplemented by investigations conducted on a more scientific basis. Among the papers read in this section were the following:

'Plant Physiology in its Relation to Agriculture and Horticulture,' by F. Woods, Chief, Division of Vegetable Physiology and Pathology, Department of Agriculture; 'Grasses and Forage Plant Investigation in Experiment Stations and the Division of Agrostology,' by T. A. Williams, Division of Agrostology; 'Laboratory and Field Work for Students in Horticulture,' by E. S. Goff of Wisconsin; 'The Educational Status of Horticulture,' by F. W. Card of Rhode Island; 'What Our Experiment Stations have done in Originating Varieties of Plants by Crossing and Selection,' by B. D. Halsted of New Jersey; 'The Relation of the Section of Seed and Plant Introduction to Experiment tSations,' by Jared G. Smith, of the Department of Agriculture; 'Vegetation House arranged for Pot Experiments, by W. E. Britton of Connecticut.

The section on Entomology had a larger attendance than usual, and there was a full program, which brought out much interesting discussion. Among the papers read were the following:

'Observations on the Banding of Trees to Prevent Injury by the Fall Canker-worm,' by W. E. Britton of Connecticut; 'Suggestions towards Greater Uniformity in Nursery Inspection Laws and Rulings,' by E. P. Felt of New York; 'Nursery Inspection and Orchard Insecticide Treatment in Illinois,' by S. A. Forbes of Illinois; 'Entomology in the Southern States,' by H. Garman of Kentucky; 'Economic Entomology in Florida,' by H. A. Gossard of Florida; 'Experiences in Nursery and Orchard Inspection' and 'Some Recent Results with Hydrocyanic Acid in Large Buildings for the Destruction of Insect Pests,' by W. G. Johnson of Maryland; 'Danger to American Horticulture from the Introduction of Scale Insects,' by Geo. B. King of Massachusetts; 'Entomological Œcology,' by C. W. Woodworth of California; 'Recent Progress in Cotton Spraying, and New Designs for Cotton Sprayers,' and 'Some Cotton Insects and Methods for Suppressing them,' by Fred W. Mally of Texas; 'Observations on *Artace punctistriga*,' by H. A. Morgan of Louisiana; 'A Little Known Asparagus Pest' and 'A Power Sprayer for Asparagus,' by F. A. Sirrine of New York; 'Notes on Crude Petroleum and its Effects upon Plants and Insects,' by John B. Smith of New Jersey; 'Nursery Inspection in a State free from San José Scale,' by H. E. Summers of Iowa.

For this section, Professor H. Garman,

of Kentucky, reported in the general session that much progress is being made in the specialization of the work of the station entomologists, in instruction in entomology in colleges, and in the improvement of facilities for research and instruction in this branch. There is a marked increase in recent years in the amount of inspection work required of station entomologists, and problems relating to the organization and management of this work require very careful thought and attention. Uniformity of inspection laws was advocated. It was shown that inspection had already caused much greater carefulness among nurserymen, thus removing one of the main causes of the dissemination of injurious pests.

In the section on college work, President J. K. Patterson, of the Kentucky Agricultural and Mechanical College, made a strong appeal for more instruction in mechanic arts in the land-grant colleges.

The Committee on the Collective Experiment Station Exhibit at the Paris Exposition made its final report through its chairman, Dr. H. P. Armsby, of Pennsylvania. This showed that the exhibit had been very successful in attracting the attention of investigators and government officials of different countries. The Association was awarded a grand prize for the exhibit as a whole, and collaborators were recognized by the award of a grand prize to Dr. A. C. True, Director of the Office of Experiment Stations; gold medals to Professors E. W. Hilgard, W. O. Atwater, C. F. Vanderford, T. B. Osborne, W. H. Jordan, W. H. Evans, L. G. Carpenter and W. A. Henry; and silver medals to Professors Elwood Mead, Milton Whitney, C. F. Curtiss, P. H. Mell and Paul Schweitzer. Dr. S. M. Babcock was also given a grand prize in recognition of his successful scientific work on behalf of dairy husbandry.

The Committee on Graduate Study at Washington made the following recommendations which were adopted by the Association:

"In view of the improbability that the Smithsonian Institution will adopt the suggestions of this Association regarding the organization of a Bureau of Graduate Study, your committee recommends that the Association take no further action in this direction.

"The Committee also believes that for the present further advantage should be taken of the foundation already successfully laid by the Secretary of Agriculture, and it therefore recommends that the Association express its appreciation of the practical efforts which he has made on behalf of this movement, and ask him to consider the practicability of enlarging the present plan for graduate study in that department, and, if he deems it wise, to invite the cooperation of other departments of the Government, in order that wider opportunities may be open to the graduates of the institutions represented in this Association, as well as of other institutions, to engage in graduate study and research in connection with the work of the national Government."

One of the most important subjects on which the Association took action at this meeting was the report of the Committee on Cooperative Work between the Department of Agriculture and the Experiment Stations. This was carefully prepared by a thoroughly representative committee after consultation with the directors of the stations and was unanimously adopted by the Association. It commended the attitude of the present Secretary of Agriculture toward closer cooperation between the Department and the stations and pointed out the different ways in which the two institutions might aid each other. It also attempted to define the principles on which the joint work should be arranged and conducted and stated these in the following language:

"Your Committee would deem it desir-

able that both the Department and the stations should feel entirely free to propose joint experimentation or to decline a proposal for such work.

"It is very clear to the Committee that the autonomy of the stations should be preserved, and that the stations should in no sense become extensions of the divisions of the Department for purposes of experimental work. Not only is the autonomy of the stations necessary to the fulfillment of their function, but autonomy in scientific investigation is equally essential. Your Committee would therefore deem it desirable, where cooperative work would seem advisable, that the agreement take the shape of a formal contract between the station, as such, and the Department, as such, through the properly authorized channels of each. That is, that the high contracting parties be the station on the one hand and the Department on the other. Arrangements between individual officers in the two institutions are deemed inadvisable except under such contract.

"The cost of cooperation should be borne jointly by the station and by the Department, and the amounts to be expended should, as far as practicable, be definitely agreed upon and specified.

"While it is understood that an absolute guarantee of continuance cannot be given, yet there should be reasonable mutual assurance of a fixed policy, until the completion of the work undertaken.

"The results of the investigation should be available to both institutions, priority of publication being a matter of mutual agreement at the outset. In all cases publications should set forth that such work is the result of joint experimentation.

"Your Committee deems it very desirable that independent work be not undertaken in the several States by the Department without the knowledge of the station or consultation with the station, particularly along lines of investigation in which the State station is engaged.

"Whenever cooperation with practical men in the States is desired by the department in investigations, it is suggested that the State station be the agency through which such cooperation is conducted. For example, if the department wishes to distribute seeds or plants for cooperative work, the knowledge both of men and physical conditions on the part of the station should be made available.

"Your Committee makes the above suggestions realizing that they are in no wise complete and that the subject is one requiring further inquiry and consideration."

The Association also passed a resolution pledging its support to the Secretary of Agriculture in his efforts to adjust the compensation of persons employed in the higher technical and scientific positions in the Department of Agriculture in such manner as to secure and retain the services of thoroughly competent officers.

The following officers of the Association for the ensuing year were elected:

President, A. W. Harris, of the University of Maine; Vice-Presidents, J. K. Patterson, of the Agricultural and Mechanical College of Kentucky; W. H. Jordan, of the New York State Experiment Station; R. H. Jesse, of the University of Missouri; L. G. Carpenter, of the State Agricultural College of Colorado; and E. A. Bryan, of the Washington Agricultural College and School of Science; Secretary-Treasurer, E. B. Voorhees, of the New Jersey Experiment Stations; Bibliographer, A. C. True, of the Department of Agriculture; Executive Committee, H. H. Goodell, of the Massachusetts Agricultural College; Alexis Cope, of the University of Ohio; G. W. Atherton, of the Pennsylvania State College, and H. C. White, of the Georgia State College of Agriculture and Mechanic Arts.

Officers of Sections: Agriculture and

Chemistry, C. D. Woods, of the University of Maine, chairman; College Work, J. H. Raymond, of the University of West Virginia, chairman; B. O. Aylesworth, of Colorado Agricultural College, secretary; Entomology, M. V. Slingerland, of Cornell University, chairman; H. A. Morgan, of Louisiana University, secretary; Mechanic Arts, H. W. Tyler, Massachusetts Institute of Technology, chairman; F. P. Anderson, of Kentucky Agricultural and Mechanical College, secretary; Horticulture and Botany, L. R. Jones, of the University of Vermont, chairman; W. J. Green, of Ohio Experiment Station, secretary.

A. C. True.

RECENT WORK ON MOLLUSKS.

The land shell fauna of the Hawaiian Islands has been discussed by E. R. Sykes, with intercalations on anatomy by Lieutenant-Colonel Godwin-Austen.* Mr. Sykes has worked upon museum material, especially that collected by Perkins and the rich stores of the British Museum and the Boston Society of Natural History. He finds the number of species much exaggerated, as every one familiar with the group was well aware. The fauna is considered to be Polynesian and to show hardly any trace of Asiatic or American influence. Oahu is the center of distribution and the most populous in Achatinellidæ. The list given is a useful one, but the monographic study of the Achatinellas from an evolutionary standpoint remains to be written.

A. S. Jensen, of Copenhagen, initiates what promises to be a series of 'Studier over Nordiske Mollusker,' by an investigation of the forms and distribution of the boreal Myas.† The paper is illustrated by some excellent figures.

* *Fauna Hawaiiensis*, II., pp. 271–412, pl. 11, 12. 1900. 4to.

† *Vidensk. Meddel. nat. Foren i Kjobenhavn*, pp. 133–158. 1900.

F. C. Baker * discusses the gross anatomy of *Limnæa emarginata* Say, var. *Mighelsi.* There are six plates, two illustrating what the author believes to be the range of variation in the form of the shell, the others, which are rather diagrammatic, illustrating the anatomy. If carefully done, papers of this kind will have a permanent value.

M. Maurice Cossmann continues his phenomenal activity in the field of Tertiary mollusks, by a paper which is to be followed by others on the 'Mollusques Éocéniques de la Loire Inférieure.'† An interesting series of forms is figured, and it is curious to see how many of them recall parallel species from our own Claibornian horizon.

Mr. W. J. Fox in a recent number (306 p. 718) of this Journal refers to a shell named by Osbeck in his 'Reise nach ost Indien und China,' 1765, *Cunnus chinensis.* The objectionable generic name was doubtless derived from Linnæus, who used it in the manuscript of the Museum Ludovicæ Ulricæ for the shell now known as *Venus dione.* It was not published by Linnæus, who substituted *Venus* in the tenth edition of the Systema Naturæ and afterward in the Museum Catalogue referred to. A very interesting account of the gradual evolution of the early Linnæan generic names, and of the binomial system itself, will be found in a paper by the late Professor Sven Lovèn 'On the species of Echinoidea described by Linnæus,' in the *K. Svensk. vet. Akad. Handl.*, Bd. 13, IV., No. 5, 1887, pp. 3–60. Luckily Osbeck's application of the name referred to seems unidentifiable.

The great Baikal Lake of Eastern Siberia has long been regarded as having had connection with the sea at some previous epoch, and various opinions have been held

* *Bulletin Chicago Acad. Sci.*, II., No. 3, pp. 191–212. June, 1900.

† *Bull. Soc. Sci. Nat. Nantes*, I., pp. 307–336, pl. XXII.–XXVI. 1900.

as to which body of sea water it was originally connected with. Dr. W. Dybowski contends that the 'stammform' of one of the Baikal sponges (*Lubomirskia baicalensis*) is an inhabitant of Bering Sea. Hoernes has regarded the fauna of the lake as analogous to that of the Sarmatic beds of Southern Europe, but this analogy is hardly greater than it bears to various other late Tertiary lake-beds, including those of our Great Basin. In the September number of the *Nachrichtsblatt der deutschen Malakozoologischen Gesellschaft*, Dybowski announces the discovery of a Nudibranch (*Ancylodoris baicalensis*, Dyb.) and the presence of numerous Trochophora larvæ in April, in the lake. These being strictly marine animals, never before reported from fresh water, the evidence as to the lake's origin seems conclusive, and its character as a 'relicten see' positively established.

Mr. Henry Hemphill has recently forwarded to the National Museum a photograph of a six-valved specimen of *Ischnochiton* obtained by him at San Diego, California. Seven-valved specimens (the normal number being eight) are known to be preserved in the British Museum and the Academy of Natural Sciences at Philadelphia; and now Mr. E. R. Sykes figures in the *Journal of Malacology* (VII., p. 164) a three-valved specimen of *Ischnochiton contractus* Reeve, from South Australia. The rarity of these abnormal individuals makes the discovery most interesting. In another note Mr. Sykes records the presence in the fauna of Natal of a species of the genus *Cryptoplax*, previously supposed to be confined to the Indo-Pacific and Australian provinces.

Dr. George W. Taylor, of Nanaimo, has added a new genus to the fauna of the Pacific coast in the shape of an undescribed species of *Phyllaplysia* (*P. Taylori*) which was found near Nanaimo on floating seaweed. The animal is of a clear lemon-yellow, about an inch in length and with a nearly smooth surface. The genus has heretofore been known only from the coasts of France and the Adriatic.

Pelseneer has been pursuing researches on the various mollusks believed to exhibit archaic features.* He devotes attention chiefly to the Chitonacea, the Docoglossa, Rhipidoglossa and Solenoconcha. His conclusions do not include any remarkable novelties, but afford in many cases additional confirmation of opinions long held or occasionally expressed by macologists. Thus he considers the metamerism of chitons to be a secondary, not primitive, condition; recognizes the features of the Docoglossa limpets which are analogous to those of the Amphineura, confirms the unlikeness of *Scissurella* to *Pleurotomaria* and the asymmetry of the epipodial processes in the Trochidæ. Some interesting new facts are recorded among the Pyramidellidæ; *Odostomia* was found to be hermaphrodite, but otherwise related to ordinary Pectinibranchs. The Scaphopods he considers to have distinct relations with the Rhipidoglossate gastropods, but one of the characters, the opening of the genital duct into the right nephridium, has already been shown to be fallacious by H. Fischer, the error being due to the torsion in the embryo. It is probable that this supposed relation will not be accepted by students of the group. In regard to the nephridia of both Docoglossate and Rhipidoglossate limpets, Professor Pelseneer is at variance with Erlanger; but in another contested hypothesis, the relation of the Placophora and Aplacophora, in which he differs from Thiele by regarding the groups as related, we believe Pelseneer to be right. At any rate, whether all details be confirmed by future research or not, the present paper contains much which will prove welcome to students of the Mollusks.

Mém. Acad. Roy. des Sci. de Belgique, LVII. 1899. Pp. 113.

Professor L. Cuenot (*Arch. de Biologie*, XVI., 1899) has published some interesting researches on the excretory organs and their functions in a variety of mollusks. In these he shows how different portions of the nephridia excrete different effete elements of the fluids of the body and how these functions are distributed. The memoir has been crowned by the Royal Belgian Academy.

An unusual condensation of embryonic stages has been observed in two nudibranchs, *Cenia cocksi* by Pelseneer, and in *Pelta coronata* by Vayssière. These embryos do not exhibit the usual embryonic velum and shell of other Opisthobranchs, but the body at an early stage becomes covered with vibratile cilia and rotates in the fluids of the egg (*Zool. Anz.*, XXIII., 1900).

In the *Proceedings of the Malacological Society* (IV., No. 3, October, 1900), Mr. M. F. Woodward gives some important information in regard to the anatomy of three members of the Volutacea, the significance of which is, however, somewhat obscured by the author's want of knowledge of the present state of the nomenclature. The paper gives a general account of the macroscopic anatomy of *Neptuneopsis Gilchristi* Sowerby, a newly described and peculiar form from South Africa, and of '*Voluta*' *ancilla* and '*Volutilithes*' *abyssicola*, Adams and Reeve. Of the anatomy of the latter nothing was known. The *Neptuneopsis* was described in a South African publication which has not reached this country, and is generally inaccessible, so it is to be regretted that Mr. Woodward did not recapitulate the shell characters for the benefit of students. The radula also had been abstracted from the specimen before it was received by him, so that the chief aids to systematic classification are wanting. However, it seems pretty certain, from the characters of the nervous system, that the animal is nearly related to the Volutidæ, and, since it has an operculum, probably to the true volutes which Mr. Woodward calls *Volutolyria*, a name which is an absolute synonym of *Voluta* (L.) Lamarck. Until more information is received it would be rash to come to more precise conclusions as to its systematic place.

The only data in relation to the anatomy of *Volutilithes* properly speaking (as far as one can judge from the shell, the type being *Voluta spinosa* Lam., a fossil species) were given by me in the *Proc. U. S. Nat. Mus.* (XII., No. 773, p. 315, 1889) from an examination of *V. Philippiana* Dall., from the South American coast. To the data there supplied it may be added that the dentition consists of a single longitudinal row of 50 tricuspid teeth, the cusps being long, thornlike and somewhat decurved. It has no operculum and is blind. This radula is most like that of *Cymba olla* L. and *Volutilithes* doubtless belongs to the *Scaphellidæ* as does *Cymbiola* (or *Scaphella*) *ancilla*. In 1890 I separated the group to which '*Volutilithes*' *abyssicola* belongs, as a subgenus *Volutocorbis*, as it obviously could not be classed with the original *Volutilithes*. This course is now fully justified by the anatomical details supplied by Mr. Woodward, the most remarkable of which is the radula, which has two rows of unicuspid laterals, one on each side of the rhachidian tricuspid tooth. This radula is unlike any of the Volutacea yet known, as *Volutomitra*, which Woodward compares with it, has, like the others, only a single row and Troschel in his text explains how the deceptive appearance of laterals in one of his figures arises from the crushing of the base under a cover glass. The single rhachidian of *Volutomitra* is well figured by Stimpson (*Bull. U. S. Nat. Mus.*, No. 37, pl. xxxiv., Fig. 7). The radula of *Volutocorbis* is intermediate between that of *Vasum* and that of *Oliva*. The group will now take rank as a distinct genus. If it remains in the Volu-

tacea it must be placed in the Scaphellidæ. The chief distinctive characters of this family, beside the conditions of the larval shell and the absence of an operculum, appear, from Woodward's researches, to be the extreme condensation of the chief ganglia around the gullet, the development of a very large œsophageal cæcum (which led Poiret to suppose *Halia* had a double œsophagus), and two pairs of preneural salivary glands. If the family is divided into two subfamilies on the basis of the radula, Volutomitrinæ with a unicuspid median tooth, will include *Amoria*, *Volutomitra* and *Halia;* while Scaphellinæ with a tricuspid tooth will include the others. The typical *Voluta* and *Lyria* have wide rhachidian teeth with many cusps, an operculum, shelly protoconch, and other characters which separate them entirely from the Scaphellidæ. According to our present knowledge one of the most important results of Mr. Woodward's labors is to show that the old family of Volutidæ included many diverse types, and that a great deal remains to be done before we can proceed to generalize with safety on those of which the nepionic stages and anatomy are unknown.

WM. H. DALL.

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*RICHTER AND THE PERIODIC SYSTEM.**

A VERY remarkable work appeared at the close of the last century. This was 'Die Anfangs-gründe der Stöchyometrie,' by J. B. Richter, the first volume of which appeared in 1792, and the third and last volume in 1794. In this book we have the first definite statement of the law of proportionality, and some have thought that they have found in it also the Atomic Theory, though it was not claimed that this theory was definitely stated.

Richter's work attracted attention at the time because of his defense in it of the phlogistic theory and it was vigorously attacked by the supporters of the New Chemistry, who followed Lavoisier and the French chemists. The deeper purport of the book and the new ideas advanced do not seem to have been well understood or to have been largely commented upon. Fischer, who in 1802 translated into German Berthollet's 'Statique Chimique,' was apparently the first to draw general attention to the work of Richter and to its bearing upon the conclusions drawn by Berthollet. This latter chemist and Guyton de Morveau acknowledged that Richter had anticipated them in the inference to be drawn from the permanence of neutrality after the decomposition of certain neutral salts and the possibility of calculating beforehand the composition of the salts produced. The discovery of the law of proportionality was a most important one and Richter must, therefore, be regarded as a very remarkable man. In his discovery that the amounts of different metals combining with a given weight of acid combine with a fixed amount of oxygen, he went a step further, anticipating the work of Gay Lussac, and when he established the fact that such metals as iron and mercury have the power of combining with oxygen in several proportions, showing different degrees of oxidation, he was several years ahead of Proust and verged upon the discovery of the law of multiple proportions.

With all his ability to see deeply into the workings of natural phenomena, Richter was not a clear and logical thinker. Wurtz rightly speaks of him as 'the profound but perplexed author of the great discovery of proportionality.' He was confused by his adherence to the illogical phlogistic theories which were becoming each year more untenable. He was further hampered by his determination to give a mathematical foundation to the science of chemistry and to express all chemical changes by formulæ

* Read before N. C. Section, Amer. Chem. Soc., Nov. 9, 1900.

and equations worked out along algebraic lines. It was, doubtless, the presence of these mathematical equations all through his volumes which deterred many chemists from a full and patient examination of them for the kernel of truth which they might contain. The average experimental chemist is not much attracted by abstruse mathematical speculations.

Later chemists commenting upon his work have made some mention of the mathematical regularities observed by him and this led me to think that perhaps Richter might have caught some glimpse of the periodic law before the conception of the atom and the atomic theory had entered into chemistry. To investigate this question it was necessary to examine Richter's writings and I was fortunate enough to secure the use of a copy of his Stöchyometrie through the courtesy of the librarian of the American Academy of Arts and Sciences.

It is of interest, first, to see how near an approach Richter made to the conception of atoms. In the preface to Volume I. the question of solution is discussed and the statement is made that "the chemist cannot boast of being able in any manner to divide a body up into the smallest parts because matter can be thought of as infinitely divisible." From many passages one may judge, however, that he held to the corpuscular view of matter, namely that it was composed of certain very small, discrete particles, which were, however, conceivably further divisible. Thus in giving the various definitions of elements he says that to one chemist the word meant the simplest indestructible substance, the subtlest material which the creator had created for the formation of all other bodies; to another it meant such materials as could not be decomposed into dissimilar particles and in which no component particles could be recognized. For himself he prefers to divorce the word from all connection with primal matter, or Urstoffe, and to make use of it simply as a part of the chemical technology, attaching to it the meaning of a body undecomposable by any means known to the chemist. Chemistry as an art, according to Richter, consisted in the ability to separate elements from one another and to bring them together as constituents of a new body. Chemistry as a science was something greater, including its theories and fundamental axioms. A chemical element, he says, is one which, without being decomposed into unlike parts, can by mixing with other kinds of matter cloak their peculiar characteristics and bring about others. It is *elementum immediatum* when it cannot be decomposed into unlike parts; *mediatum* when it can be thus decomposed (p. 5 seq.).

Thus, as Richter adds in a footnote, vitriolic acid is an *elementum immediatum*, since no one has been able to decompose it into unlike parts, but sulphur is an *elementum mediatum*, since any one knows that it can be decomposed into vitriolic acid and phlogiston and reformed from these two. This is of interest as showing the degree of knowledge on which he based his reasoning. His corpuscles are called 'Theilganzen,' and in these the force of affinity resides. Thus he states, "to each infinitely small particle of the mass of an element there belongs an infinitely small portion of the chemically-attracting force of affinity" (p. 123).

The part of Richter's work which appears to refer most nearly to the periodic system is found in his second volume on page vi of the preface. He refers to the fact that the supposition had already been made in a paper on the 'Newer Objects of Chemistry, especially the recently discovered half-metal Uranium,' that the affinities of many chemical elements towards any single one might be in a definite progression. This sup-

position, says Richter, has already in the case of four quantitative series been raised to the dignity of an incontrovertible rule. The tables of masses form arithmetical progressions and the affinities of the elements which belong to the series, proceed also, in so far as they are not disturbed by the indwelling elementary fire, in the order of the masses. Besides one is in position to see the probability of many homogeneous elements present in nature. Also the doubled affinities proceed in arithmetical progression and with careful observations one can scarce resist the thought that *the entire chemical system consists of similar progressions.*

It is well to examine a series given by Richter to get more fully at his meaning. Thus in the same volume, page 28, he gives the masses of the alkaline earths which neutralize 1,000 parts of hydrochloric acid.

Magnesia $734 = a$

Lime $858 = a + b \ (734 + 124\tfrac{1}{2} = 858\tfrac{1}{2})$

Alumina $1{,}107 = a + 3b \ (734 + 3 \times 124\tfrac{1}{2} = 1{,}107\tfrac{1}{2})$

$= a + 5b \ (734 + 5 \times 124\tfrac{1}{2} = 1{,}356\tfrac{1}{2})$

$= a + 7b \ (734 + 5 \times 124\tfrac{1}{2} = 1{,}605\tfrac{1}{2})$,

etc.

Baryta $3{,}099 = a + 19b \ (734 + 19 \times 124\tfrac{1}{2} = 3{,}099\tfrac{1}{2})$

Similar series are given for the alkalies and alkaline earths with the different acids. Again these tables are compared with one another and thus was brought out the law of proportionality. One of the most remarkable regularities is obtained by examining the differences in the masses in such a series made up of observed combining numbers of known elements and interpolated combining numbers of hypothetical elements. Thus (p. 38):

$$616 - 526 = 90 = 1 \times 90$$
$$796 - 526 = 270 = 3 \times 90$$
$$973 - 526 = 447 = 5 \times 90 - 3$$
$$1{,}152 - 526 = 626 = 7 \times 90 - 4$$
$$1{,}330 - 526 = 804 = 9 \times 90 - 6$$

etc., etc.

Of course, it is readily seen that all these regularities are more in the line of the triads of Döbereiner or the later work of Dumas than the periodic system. But a close examination reveals something more —a really deeper insight into the nature of the elements which is marvellous when one considers that Richter was dealing with compounds not elements, and with combining numbers and not atomic weights. First, one must note his statement of the belief that 'the entire chemical system consists of like progressions.' To his mind the elements formed a system correlated and made up of progressions. This is, of course, not the ascending series of de Chancourtois and Newlands, but it seems to me a position much nearer to it than was reached by any chemist for more than half a century afterwards.

Again, in other portions of this volume Richter speaks of the necessity of deducing quality from quantity and vice versa. Thus he points out that the series of masses mentioned as forming arithmetical progressions are really series of affinities also, and the relative affinities might be deduced from the relative masses. Much space is given also to the effort at tracing relationships of the specific gravities. While it cannot be positively stated that Richter foresaw that important part of the periodic law that the properties of the elements are dependent upon the weights, he seems at least to have been possessed with the idea that what he called the masses of the elements had something to do with what he considered the qualities, or that they progressed similarly. And that they in the main progress similarly is about all that we know with regard to them at the present day.

I acknowledge that there is some difficulty in sifting out Richter's full meaning from the mass of mathematical calculation and one must be careful to avoid reading into his work the thought of later years. It is not strange that the tedium of following such involved calculations and specu-

lations as his should have deterred his contemporaries from following his trend of thought or paying much attention to him. It cannot be claimed that he preceded Dalton in his conception of the Atomic Theory, but Richter belongs to the number of the great original thinkers of chemistry and it is time that greater justice be done him.

F. P. VENABLE.

VERTEBRAL FORMULA OF DIPLODOCUS (MARSH).

THE splendid skeleton of Diplodocus, discovered in the Como Bluffs of Wyoming by the American Museum party of 1897, has enabled Professor Osborn to very materially increase our knowledge of the osteology of that genus.* Interesting and unique as was the material that formed the basis of Professor Osborn's memoir, it nevertheless left many questions unsettled concerning the osteology of Diplodocus. In 1899 a second skeleton was discovered in the Dinosaur beds of the Upper Jurassic, near Sheep Creek, in Albany County, Wyoming, by Dr. J. L. Wortman, while engaged as Curator of Vertebrate Paleontology of this Museum, in exploring the fossil-bearing horizons of that region.

The second skeleton of Diplodocus was very carefully exhumed under the skillful direction of Dr. Wortman, and has since been entirely freed from the matrix and temporarily mounted by Mr. A. S. Coggeshall, Chief Preparator in the Department of Paleontology.

Now that this material is available for study, it proves to supplement in a remarkable manner the skeleton belonging to the American Museum. A detailed description of our material will be given in a paper by the writer which it is proposed to have appear among the memoirs of this institution. In the present note only the vertebral column will be considered, and no attempt will be made to describe this in detail, but rather to correct some errors concerning the vertebral formula of Diplodocus as given by Osborn in his memoir cited above, and by Dr. W. J. Holland, in a subsequent paper entitled 'The Vertebral Formula in Diplodocus, Marsh,' published in this JOURNAL, May 25, 1900, and based upon the material now under discussion.

About 45 feet (14 meters) of the vertebral column is preserved in our specimen. When discovered the vertebræ did not lie in a connected and unbroken series, yet there can be little doubt that they all pertain to the same individual, and they have been mounted as a continuous series commencing with the axis and ending with the twelfth caudal. In all 41 vertebræ are represented, including 14 cervicals (all but the atlas), 11 dorsals, 4 sacrals and 12 caudals.

Assuming that no vertebræ are missing from our series the vertebral formula of Diplodocus should now be written as follows:

Cervicals, 15.
Dorsals, 11.
Sacrals, 4.
Caudals, 37, as estimated by Osborn, not 35, as attributed to him by Holland.

The above vertebral formula will be seen to differ from that given by Holland, the latest contributor on this subject, as follows:

1. The number of cervicals is at least 15.
2. There are 11 dorsals instead of 10, as fixed by Holland, who mistook the first presacral of Osborn for a sacral.

There are 4 sacrals, as given by Osborn and Holland, while the number of caudals is still placed at 37, as estimated by Osborn. Of the caudals, only the 12 anterior are preserved in our skeleton, and the second and third of these have coossified centra.

In placing the number of dorsals at 11, I am assuming that Osborn is right in considering the first vertebra with a free spine,

* See 'A Skeleton of Diplodocus,' Part V., Vol. I., Mem. Am. Mus. Nat. Hist., pp. 191–214

anterior to the 3 sacral vertebræ with coalesced spines as a dorsal rather than a sacral. I also assume that we have represented in our skeleton the complete dorsal series, but of this we cannot be absolutely certain, since the vertebræ were not found in an articulated series. Unfortunately no diagram was made, at the time of exhuming the remains, showing the relative position of each of the vertebræ in the quarry. Early last spring, at the request of the writer, Mr. W. H. Reed (who assisted in unearthing the skeleton), while again on the ground, made a diagram of the quarry, showing the relative positions, as he remembered them, of the various bones of the skeleton. This diagram shows two rather marked breaks in the vertebral column, and I may add that a close examination of the dorsal series as now mounted seems to indicate that there are two or more missing vertebræ. This is especially noticeable between presacrals 7 and 8 or dorsals 5 and 4. In presacral 7, the capitular facet is situated well up, on the side of the neural arch, while in the presacral immediately anterior it extends well down on the centrum. Not only does this sudden shifting of the position of this articular surface seem to indicate that there are wanting at this point in the series one or more vertebræ, but I may add that according to Professor Osborn's figures the actual position of the capitular facet on presacral 8 is much higher than that occupied by that facet on the vertebra that has been assigned to the same position in our series, thus indicating a more anterior position for this vertebra, and consequently a greater number of dorsal vertebræ than has been given above. Since the vertebræ in the American Museum series were all found interarticulated by their zygapophyses, there can be no question of the position of each dorsal in that series, relative to the sacrum. There also appears to be a break in our series between the last cervical and the first dorsal, and it is barely possible that the first true dorsal or last cervical is wanting in our series. From the above it will be seen that there is a possibility that when the actual number of dorsal vertebræ in Diplodocus is definitely known, it will be somewhat greater than that given here, and that Professor Marsh was perhaps not far wrong when he figured it at 14.

Should the first vertebra anterior to the three sacral vertebræ with coalesced spines come eventually to be considered as a sacral, rather than a dorsal, the sacrum would then have to be considered as composed of 5 vertebræ instead of 4, as has been done by Osborn, Holland and the present writer. If we consider this vertebra as a modified dorsal and not a sacral, there would seem to be no good reason why we should not consider the fourth sacral, which also has a free spine, as a modified caudal, since the centra of each are firmly ankylosed with the sacrals bearing coössified spines. This interpretation would reduce the number of true sacrals to 3, as was originally given by Marsh.

Another marked character brought out by our skeleton is the great absolute and proportionate length of the cervical region in Diplodocus. Osborn has given the known and estimated lengths of the vertebral column as follows:

Caudals, 30 feet.
Sacrals, 2 feet.
Dorsals (estimated) 12 feet.
Cervicals (estimated) 12 feet.
Skull, 2 feet.

The length of the cervical series alone in our skeleton is somewhat over 21 feet; and the atlas is yet to be found. The dorsal series is somewhat shorter than that estimated by Osborn.

The main points that it is desired to emphasize are:

1. The number of cervical vertebræ in Diplodocus is definitely fixed at at least 15.

2. There are at least 11 dorsal vertebræ, perhaps two or three more.

3. The great comparative and absolute length (21 feet) of the cervical series, a striking analogy to that exhibited in the struthious birds.

4. The actual number of dorsals in Diplodocus seems to be 11, but cannot be definitely determined from our skeleton, and we must await further discoveries for its solution.

J. B. HATCHER.

CARNEGIE MUSEUM.

PLANT GEOGRAPHY OF NORTH AMERICA. III.

THE LOWER AUSTRAL ELEMENT IN THE FLORA OF THE SOUTHERN APPALACHIAN REGION. A PRELIMINARY NOTE.*

IN that portion of the United States which lies south of the Potomac and Ohio Rivers and east of the Mississippi, three principal orographical areas are readily distinguishable. These are generally known as the Pine Barren or Low Country (Coastal Plain), the Piedmont or Middle Country and the Mountains or Upper Country. Their respective characteristics—climatic, physiographical and biological—have been so often described in popular and scientific writings that to enumerate them here would be superfluous. So obvious are their distinguishing features, that no observant traveler fails to take note of them as he crosses the southeastern States.

The altitudinal limits of these three areas coincide roughly with those of three great continental life zones, *i. e.*, the Lower Austral Zone in its humid or Austro-riparian Area; the Carolinian Area of the Upper Austral, and the Alleghanian Area of the Transition Zone.*

The Coastal Plain, presenting but scant diversity in its orography, is occupied almost exclusively by a Lower Austral fauna and flora. In the Piedmont Region the surface of the country is less uniform and we encounter within its general boundaries many scattered localities where conditions permit the occurrence of Lower Austral or of Transition colonies amid the prevailing Carolinian life. But in the Mountain Region there exists such a variety of conditions that all the life zones from Lower Austral to Hudsonian are represented in places, although their limits are here very ill-defined, and the precise location of them presents many intricate problems.

Thus along the higher Smoky Mountains and the Blue Ridge, we find a typically Canadian forest of firs (*Abies Fraseri*), accompanied by such trees and shrubs as the yellow birch (*Betula lutea*), mountain ash (*Sorbus americana*), mountain maple (*Acer spicatum*), red elder (*Sambucus racemosa*) and wild red cherry (*Prunus pennsylvanica*). Other characteristically Canadian species like the striped maple (*Acer pennsylvanicum*), hemlock (*Tsuga canadensis*), white pine (*Pinus Strobus*) and the arbor vitæ (*Thuya occidentalis*) descend to much lower elevations (900 meters or less). Along the crest of the highest mountains of this region, usually at an altitude of 1,800 meters (6,000 feet) or upwards, a sparse Hudsonian flora is encountered. The green alder (*Alnus viridis*), and, of herbs, *Arenaria groenlandica*,

* In the matter of nomenclature, in this paper, I have followed that employed by Britton and Brown in their 'Illustrated Flora of the Northern United States and Canada.' But in order to be understood by readers who are not familiar with that nomenclature, I have added, in parentheses, the synonym generally current among American botanists before the adoption of the 'Rochester Code,' wherever a change has been made under that code.

* For a definition and description of these zones see Merriam in *Nat. Geogr. Mag.*, 6 : pp. 220–238, Maps, 1894. Also, 'Life Zones and Crop Zones of the United States'; Bull. Div. Biol. Survey, U. S. Dept. Agric., 10 : pp. 18–33, Map, 1898 (with a correction of the temperature data), in SCIENCE 9 : No. 212, p. 116 (1899).

Potentilla tridentata, and *Trisetum subspicatum*, may be regarded as typical of this zone.

By far the greatest part of the surface of the mountain region is covered with an Alleghanian (Transition) flora. To this zone may be reckoned such woody species as the cherry birch (*Betula lenta*), species of Magnolia (*Umbrella*, *acuminata*, *Fraseri*), sugar maple (*Acer saccharum*), the big laurel (*Rhododendron maximum*), mountain laurel (*Kalmia latifolia*), etc. Mingled with these are black walnut (*Juglans nigra*), tulip tree (*Liriodendron tulipifera*), shag-bark and mocker-nut hickories (*Hicoria ovata* or *Carya alba* and *H. alba* or *Carya tomentosa*), white and chestnut oaks (*Quercus alba* and *Q. Prinus*), holly (*Ilex opaca*), chestnut (*Castanea dentata*), witch hazel (*Hamamelis virginiana*) and beech (*Fagus americana*, or *ferruginea*) which are perhaps somewhat more characteristic of the Alleghanian flora, but are hardly less abundant in the Carolinian.

The lower slopes of the mountains and the valleys between are largely occupied by extensions of the Upper Austral (Carolinian) Zone. Very characteristic species, especially along the streams, are buttonwood (*Platanus occidentalis*), river birch (*Betula nigra*), linden (*Tilia heterophylla*), hackberry (*Celtis occidentalis*), sweet gum (*Liquidambar styraciflua*), red mulberry (*Morus rubra*), sassafras (*Sassafras officinale*), persimmon (*Diospyros virginiana*), tupelo (*Nyssa sylvatica*), and species of pine, notably the scrub pine (*P. virginiana* or *inops*), and the yellow pine (*P. echinata* or *mitis*). Usually intermingled with these are numerous partially Transition species, *e. g.*, beech and American elm (*Ulmus americana*). The dried summer slopes add to this list such species as the chinquapin (*Castanea pumila*), sourwood (*Oxydendrum arboreum*) and black-jack oak (*Quercus marylandica* or *nigra*).*

Growing amid the often very large body of Carolinian forms, thus established in the region we are considering, there occurs a much smaller number of species which are most abundant in and characteristic of the Austro-riparian area of the Lower Austral Zone. Only two or three trees and comparatively few shrubs which are distinctly of the Lower rather than the Upper Austral Zone extend into the mountain region. But of herbs the number is a respectable one. Over one hundred species which are most abundant and most widely distributed in the Austro-riparian area are known to occur in the mountains at an elevation of 300 meters (1,000 feet) or more.

A faint indication of this Lower Austral element is perceptible as far north as West Virginia and southeastern Kentucky; while, on the mostly isolated granitic outcrops in northern central Georgia and northern Alabama, of which Stone Mountain is a type, it is so extensive as somewhat to obscure the mainly Carolinian character of the flora. In the former case the Austro-riparian forms are few and unimportant. In the latter instance the stations are so inferior in elevation, are so nearly isolated from the principal mountain chains and are so close to the main borders of the Austro-riparian area as to possess small significance as extensions of that area. Hence we had best confine ourselves here chiefly to that portion of the Appalachian Region which falls within the limits of North Carolina and Tennessee. Here we find some of the highest elevations of eastern North America; and therefore we are justified in regarding as of peculiar interest the presence in their neighborhood of numerous essentially Lower Austral forms of plant life.

It may be well to limit still further the scope of the present investigation by omitting from discussion species which do not reach

*I have purposely omitted from the above lists such species as are endemic in the Southern Appalachian Region, as being less suitable to indicate the general zonal relationships.

an elevation of 300 meters (1,000 feet). Below that altitude, the flora of the Southern Appalachian Region is mainly Carolinian, and the presence in its midst of numerous Austro-riparian forms would be expected. The occurrence of Lower Austral species at higher elevations, in the midst of a chiefly Transition flora is the phenomenon which demands our attention.*

Some of the species occurring on Lookout Mountain, but not reported from other stations in the mountains, *e. g.*, *Pinus Taeda*, *Cebatha carolina* (*Cocculus carolinus*), *Vaccinium arboreum* and *Spigelia marilandica*, also extend farther up the Tennessee Valley. Finally a considerable number of Lower Austral species, which are encountered rather rarely among the mountains, are frequent or common along the Tennessee River, near Knoxville (elevation 270 meters). We may cite:

Poa Chapmaniana.
Arundinaria macrosperma.
Arundinaria tecta.
Yucca filamentosa.
Agave virginica.
Centrosema virginiana.
Hypericum densiflorum.
Hypericum virgatum.
Callicarpa americana.
Aster concolor.
Tetragonetheca helianthoides.
Helenium nudiflorum.

The Austro-riparian species which are met with in the region thus defined do not always grow scatteringly among Carolinian forms. Not infrequently, in peculiarly favorable localities, such as the diminutive pine barrens which cover sandy river bottoms and the dry, sunny lower slopes of the hills, they occur in numbers so pronounced that a botanist suddenly set down amongst them might be puzzled for a moment as to his zonal whereabouts. Yet a two or three hours' walk would take him through a typical Transition vegetation into that which is almost wholly Canadian. Two colonies of this character with which I am personally familiar are worthy of more detailed description.

Along the French Broad River below Paint Rock, North Carolina, and just within the limits of Tennessee, the stream is bordered by limited strips of flat land, which are mostly covered by a small growth of yellow pine (*Pinus echinata* or *mitis*), with frequent clearings among the trees. The altitude of the river-banks is here from 345 to 360 meters (1,150 to 1,200 feet) above the sea. In these groves the herbaceous flora is, as it were, a bit of the carpet of the coastwise pine-barrens, which has been laid down intact along the banks of a mountain stream. The following list of species, all of which are abundantly represented, indicates the character of this flora. It will be noticed that Gramineæ, Leguminosæ and Compositæ contribute a very large proportion.

Erianthus alopecuroides.
Andropogon argyræus.
Chrysopogon nutans var. *Linnæanus.*
Sporobolus asper.
Danthonia sericea.
Gymnopogon ambiguus (*G. racemosus*).
Triodia Chapmani.
Cratægus uniflora (*C. parvifolia*).
Morongia angustata (*Schrankia angustata*).
Cracca spicata (*Tephrosia spicata*).
Stylosanthes riparia.
Rhynchosia erecta.
Croton glandulosus.

* Naturally the extent of Lower Austral invasion is greatest along the water-courses of the region. Thus, in the valley of East Tennessee, which is in much of its length fully one hundred miles wide between the Great Smokies southeastward and the Cumberland Range towards the north and west, there occur at an elevation of 240 to 270 meters not a few typically Austro-riparian species which apparently do not penetrate those smaller mountain valleys which are situated above 300 meters. Examples are:

Agrostis Elliottiana.
Ampelopsis cordata (*Cissus Ampelopsis*).
Cynoctonum Mitreola (*Mitreola petiolata*).
Nemophila microcalyx.
Lithospermum tuberosum.
Diapedium brachiatum (*Dicliptera brachiata*).
Eupatorium incarnatum.

Vitis rotundifolia.
Hypericum Drumondii.
Bignonia crucigera (*B. capreolata*).
Elephantopus tomentosus.
Eupatorium aromaticum.
Chrysopsis graminifolia.
Silphium Asteriscus.
Silphium compositum.

Another noteworthy Austro-riparian colony occurs at a mean elevation of about 300 meters (1,000 feet), in the cañon-like valley of the Hiwassee River, in extreme southeastern Tennessee. Here the number of almost purely Lower Austral Gramineæ is particularly striking. Some of the most important species are:

Erianthus alopecuroides.
Erianthus contortus.
Erianthus brevibarbis.
Andropogon argyræus.
Andropogon Elliottii.
Paspalum purpurascens.
Panicum gibbum.
Panicum viscidum.
Danthonia sericea.
Uniola longifolia.
Poa Chapmaniana.
Decumaria barbara.
Baptisia alba.
Aralia spinosa.
Ptilimnium capillaceum (*Discopleura capillacea*).
Phlox amœna.
Melothria pendula.
Lacinaria graminifolia (*Liatris graminifolia*).
Helianthus angustifolius.

Lookout Mountain, especially near its southwestern end, in Alabama, harbors a notable colony of Lower Austral plants; but the precise altitudes at which most of the species occur are not known to me. Some of them which have not been reported from other stations in the mountains are:

*Pinus Tæda.**
Xyris communis.
Asimina parviflora.
Cebatha carolina (*Cocculus carolinus*).
Sarracenia flava (var. *oreophila*).
Crotonopsis linearis.
*Berchemia scandens.**
Vaccinium arboreum.
*Gelsemium sempervirens.**
Spigelia marilandica.
Yatesia læte-virens (*Gatesia laete-virens*).*
Chondrophora virgata (*Bigelovia nudata virgata*).

These three localities are but a few among many which could have been selected to illustrate the extension of Lower Austral species beyond the normal altitudinal limits of their zone. Hardly a warm lower slope or a sunny valley in the mountains but shelters a greater or less number of them. The mapping of these colonies is one of the nicest and one of the most interesting pieces of work that awaits the future investigator of local floras in this territory, for it goes without saying that it is impossible to indicate them on any general map of the Southern Appalachian region.

Let us now examine more in detail the composition of the flora which occupies these outposts of the Lower Austral Zone. A category which may be eliminated at the outset embraces those species which have been introduced into the mountains by the direct or indirect agency of man. Here belong a number of, for the most part, indigenous weeds which are common in waste and cultivated land in the low country of the southeastern United States, and which have penetrated the Appalachian region chiefly along the railways, *e. g.*:

Cynodon Dactylon.
Commelina nudiflora.
Croton glandulosus.
Croton monanthogynos.
Passiflora incarnata.
Polypremum procumbens.
Sitilias caroliniana (*Pyrrhopappus carolinianus*).
Eupatorium capillifolium (*E. fœniculaceum*).
Helenium tenuifolium.

Of the lower Austral species whose occurrence in the Appalachian region can not be referred to the agency of man, the greater number—about sixty per cent.—range elsewhere beyond the limits of the

* Occurrence on Lookout Mountain needs confirmation.

Lower Austral Zone as generally recognized.* In other words they have a latitudinal, as well as altitudinal, extra-zonal extension. Yet because of their much wider distribution and greater abundance within the proper limits of that zone, they are to be regarded as essentially Lower Austral species.

This majority becomes, however, a small minority and the percentage is reduced to about twenty-five, if we exclude species whose northward extra-zonal range extends only as far as eastern Maryland, Delaware or southern New Jersey. When we consider how largely the Carolinian flora of this latter section is diluted with Austro-riparian forms, almost to the obscuring of its true zonal relationship, we can not attach very great weight to the occurrence here of any particular Lower Austral species. Or, better expressed, the extension of such a species into the heart of the Appalachian region must be regarded as more significant than its occurrence in the Coastal Plain no farther north than southern New Jersey.

Of that large minority of Lower Austral species of the Appalachian region which exceed the general zonal limits in altitude but not in latitude, the following is a preliminary and, doubtless, very incomplete list:

Erianthus alopecuroides.
Erianthus brevibarbis.
Erianthus contortus.
Chrysopogon nutans var. *Linnæanus.*
Paspalum longipedunculatum.
Paspalam purpurascens.
Panicum gibbum.
Panicum longipedunculatum.
Triodia Chapmani.
Uniola longifolia.
Arundinaria macrosperma.
Cyperus echinatus (*C. Baldwinii.*)
Lilium carolinanum.
Ulmus alata.
Asimina parviflora.
Cebatha carolina (*Cocculus*).
Sarracenia flava (var. *oreophila*).
Parnassia grandifolia.
Decumaria barbara.
Morongia angustata (*Schrankia*).
Baptisia alba.
Psoralea pedunculata.
*Berchemia scandens.**
Vaccinium arboreum.
*Gelsemium sempervirens.**
Phlox amæna.
Callicarpa americana.
Yatesia laete-virens (*Gatesia*).*
Melothria pendula.
Elephantopus tomentosus.
Chondrophora virgata (*Bigelovia*).
Aster purpuratus (*A. virgatus*).
Pluchea petiolata.
Antennaria solitaria Rydberg (*A. plantaginifolia* var. *monocephala* Torr. & Gray).
Silphium compositum.
Tetragonetheca helianthoides.
Coreopsis auriculata.
Coreopsis major (*C. senifolia*).
Helenium nudiflorum.

The presence, at an elevation of 300 meters or more, of this considerable number of Austro-riparian species which nowhere else venture beyond the limits of their life zone, is, on the whole, the most noteworthy fact in regard to the Lower Austral element in the highland flora of the Southern States. Species of this category would appear to possess less general tendency to exceed their zonal limits than do those which range farther northward, and this enhances the interest of their occurrence in the mountains.

We now come to the difficult question of the probable past history of the Lower Austral plants which occur to-day in the Appalachian region. Are they relics of a flora once more widely distributed there, or are they the vanguard of an invading army from lower altitudes and latitudes? Al-

* The Austro-riparian Area, as defined by Merriam in various papers (recently in Bull. 10, Div. Biol. Survey, U. S. Dept. Agric.) reaches its most northern limits at the mouth of Chesapeake Bay; in extreme southwestern Indiana, southern Illinois and southeastern Missouri; and in southeastern Kansas.

* Occurrence in the Appalachian region as above defined somewhat doubtful.

though the answer must be largely speculative, it is hardly a pure assumption that both cases may be true in part. In studying this floral element, one soon reaches the conclusion that it comprises two categories of species which are markedly different not only in their systematic relationships, present distribution in the region and probable past history, but even, to a considerable degree, in their ecological constitution. But, in some cases, it is almost impossible to decide to which of the two groups a given species should be referred.

1. Plants of probably neotropical origin which have in all likelihood made their first appearance in the Appalachian region in geologically very modern times, probably after the close of the so-called Glacial Epoch. The following list embraces species which, from their distribution elsewhere, or from their affinities, are most likely to have had this history :*

Erianthus alopecuroides.
Erianthus brevibarbis.
Erianthus contortus.
Andropogon argyræus.
Andropogon Elliottii.
Chrysopogon nutans var. *Linnæanus.*
Paspalum longipedunculatum.
Paspalum purpuracens.
Panicum gibbum.
Panicum angustifolium.
Panicum longipedunculatum.
Panicum viscidum.
Muhlenbergia capillaris.
Sporobolus asper.
Gymnopogon ambiguus.
Triodia Chapmani.
Cyperus echinatus (*C. Baldwinii*).
Kyllinga pumila.
Xyris communis.
Commelina erecta.
Commelina hirtella.
Yucca filamentosa.
Agave virginica.
Pogonia divaricata.
Phoradendron flavescens.
Asimina parviflora.
Cebatha carolina (*Cocculus*).
Morongia angustata (*Schrankia*).
Cracca spicata (*Tephrosia*).
Stylosanthes riparia.
Bradburya virginiana (*Centrosema*).
Clitoria mariana.
Rhynchosia erecta.
Crotonopsis linearis.
Ascyrum stans.
Hypericum densiflorum.
Hypericum Drummondii.
Hypericum virgatum.
Rhexia mariana.
Jussiæa decurrens.
Gelsemium sempervirens.
Cynoctonum Mitreola (*Mitreola petiolata*).
Spigelia marilandica.
Callicarpa americana.
Gratiola sphærocarpa.
Gratiola viscosa.
Bignonia crucigera (*B. capreolata*).
Yatesia læte-virens (*Gatesia*).
Diodia virginiana.
Melothria pendula.
Elephantopus tomentosus.
Eupatorium album.
Eupatorium aromaticum.
Lacinaria graminifolia (*Liatris*).
Chrysopsis graminifolia.
Chondrophora virgata.
Pluchea petiolata.
Silphium Asteriscus.
Silphium compositum.
Tetragonotheca helianthoides.
Helianthus angustifolius.
Helianthus atrorubens.
Coreopsis major (*C. senifolia*).
Coreopsis auriculata.
Marshallia lanceolata var. *platyphylla.*
Helenium nudiflorum.

By far the greater number of species in the above list belong to groups, whether genera, tribes or families, which are chiefly tropical in their present distribution. Thus of the three most largely represented families, the Gramineæ belong chiefly to the tribes Andropogoneæ and Paniceæ; the Leguminosæ to Mimosæ and Phaseolæ; and the Compositæ to Eupatoriæ and Helianthoideæ. This category is furthermore remarkable in consisting almost entirely of herbaceous species. Most of them are of distinctly xerophytic structure, loving a dry sandy soil and much light and heat.

2. Plants, probably not of neotropical origin, which are, in several cases, probably the more or less modified descendants of that characteristic flora which in later Eocene or in Miocene time extended to high northern latitudes, also occupying the mountainous parts of what is now the North Temperate Zone.* Of this category, the number of identical species occurring both in the Coastal Plain and in the Appalachian region is notably smaller than in the first group. To be reckoned here, with more or less confidence, are:

Danthonia sericea.
Uniola gracilis.
Uniola longifolia.
Poa Chapmaniana.
Arundinaria macrosperma (?).
Arundinaria tecta (?)
Lilium carolinanum.
Ulmus alata.
Parnassia grandifolia.
Decumaria barbara.
Itea virginica.
Cratægus uniflora.
Cratægus rotundifolia.
Berchemia scandens.
Ampelopsis cordata.
Vitis rotundifolia.
Aralia spinosa.
Dendrium buxifolium (*Leiophyllum*).
Leucothoë racemosa.
Oxydendrum arboreum.
Gaylussacia dumosa.
Vaccinium arboreum.
Symplocos tinctoria.
Chionanthus virginica.
Antennaria solitaria.

Most of the species, as well as many of the genera, comprised in this second category are characteristic neither of tropical nor of high northern regions. They belong in great part to groups which are most largely represented at present in the mountainous parts of the Warm Belt of the Northern Temperate Zone, in both the Eastern and Western Hemispheres. Some of them, however, are of floral types which are to-day most highly developed in the tropics. Such are the species of *Arundinaria*, *Berchemia scandens*, *Ampelopsis cordata*, *Aralia spinosa* and *Symplocos tinctoria*. Yet the groups to which several or all of these species belong, formerly had a much wider extra-tropical distribution than is now the case. A few plants of this category, *i. e.*, the species of *Poa*, *Parnassia* and *Antennaria* belong to genera of mainly boreal and alpine distribution.

To be considered in connection with this second category of the Lower Austral species which occur both within the main limits of the Austro-riparian area and in the mountains, is a very significant group of genera which are represented in eastern North America by two closely allied species or group of species, one in the Coastal Plain, the other in the Appalachian region.

With the exception of *Clethra* (which is largely tropical) all these genera, like many of those represented by species of the second category, have their present center of distribution in the warmer part of the North Temperate Zone. This may be said also of the larger groups to which many of them belong, *e. g.*, the families Calycanthaceæ, Sarraceniaceæ, Hamamelidaceæ and Monotropaceæ, and the tribes Hydrangeæ of Saxifragaceæ and Andromedeæ of Ericaceæ. Some of them are known to belong to floral types which were very widely distributed in the Northern Hemisphere during the earlier part of the Tertiary, in not a few cases ranging as far north as Greenland and Alaska; and we may be permitted to con-

* According to De Saporta et Marion (Recherches sur les végétaux fossiles de Meximieux; Archiv. Mus. Hist Nat. de Lyon, 1: 304–324 (1875), a vegetation of Magnolia, Lauraceæ, Liquidambar, Anonaceæ, Ilicaceæ, Liriodendron, etc., occurred on the mountains of southeastern France, at altitudes of 200 to 700 meters, during the Pliocene. That a similar flora flourished contemporaneously in the mountains of eastern North America would seem by no means unlikely. If so, the Pliocene flora of the Appalachian region must have borne considerable resemblance to that which prevails there to-day.

jecture that the ancestors of most of these genera whose actual history is still undisclosed were thus distributed during Miocene time. Very broadly speaking, several of these genera represent groups which appear to be on the wane, as distinguished from the dominant and, one may say, aggressive types of presumably neotropical origin to which the species of the first category chiefly belong.

Genus.	Coastal Plain Species.	Appalachian Species.
Butneria (*Calycanthus*).	*florida.*	*fertilis* (*glauca*).
Sarracenia.	*flava.*	*flava* var. *oreophila.*
Philadelphus.	*grandiflorus.*	*inodorus.*
		hirsutus.
Hydrangea.	*quercifolia*	*radiata.*
		cinerea.
Fothergilla.	*carolina* (*Gardeni*).	*arborescens.*
Stuartia.	*Malachodendron* (*virginica*).	*major.*
Clethra.	*alnifolia.**	*pentagyna.*
Monotropsis (*Schweinitzia*).	*Reynoldsiæ.*	*acuminata.*
Leucothoë.	*axillaris.*	*odorata.*
	*racemosa.**	*Catesbæi.*
Pieris.	*phyllyreifolia.*	*recurva.*
Mohrodendron (*Halesia*).	*dipterum.*	*floribunda.*
	parviflorum.	*carolinum* (*tetraptera*).

In another important respect the second category differs from the first, *i. e.*, in its ecological character. A majority of the species which it comprises are woody plants, shrubs, lianas or trees; and this majority becomes a large one if we take into account the list of representative species just given. The first category, as we have seen, consists almost wholly of herbaceous forms.

A considerable number of species of the second category, notably several of the woody plants with thick, more or less persistent, leaves is essentially xerophytic in structure. But the xerophilous leaf-structure is here in most cases probably a consequence of the long duration of that organ and a protection against winter conditions, rather than an adaptation to the effects of climate and soil during the growing season. On the other hand, the number of shade-loving tropophytes or mesophytes is decidedly greater than in the first category. The plants of the second category are more often scattered among Transition and Carolinian vegetation, showing generally little tendency to form well-defined Lower Austral colonies. Finally, they are, on the whole, less characteristic of the Austroriparian area, as distinguished from the Carolinian area, than are many of the species of our first category.

Having thus segregated the two principal groups of species which constitute the floral element under discussion, are we in a position to draw conclusions as to its past history? The answer must be that it is possible as yet to formulate only broad generalizations which are hardly more than pure hypotheses. The paleontological record, during the period which doubtless witnessed the gradual rearrangement of the plant covering of the Southern Appalachian country in its present form, *i. e.*, from the Pleistocene to the present, is fragmentary in the extreme for the region in question. We can get only glimpses of what may have been the course of events. Here and there a headland can be seen, but the trend of the intervening shore-line is only to be guessed at.

* Ranges beyond the northern limits of the Austro-riparian area.

That there is reason to modify the formerly current assumption that extremely low temperatures existed in the Northern Hemisphere during the Glacial Epoch is now urged by not a few authorities.* In a paper which advocates revision of preconceived ideas on this point, Vater † calculates that points in middle Germany which were not distant from the edge of the great Ice Sheet, possessed, during the Glacial Epoch, a mean annual temperature of 4° C., as compared with 10.6° C. at the present day. But even this amount of difference must have wrought great changes in the vegetation, and, if the same ratio obtained in eastern North America, we may well assume that no member of what constitutes to-day the characteristic Austro-riparian flora could have maintained itself in the Appalachian region, during the climax of the Ice Age.* For we must remember that the great glacier made its way southward as far as the present location of Cincinnati, on the Ohio River, and extended to the southern shore of Staten Island.†

We may premise, therefore, with considerable confidence, that any portion of the Lower Austral flora of to-day which may have inhabited the Appalachian region prior to the Pleistocene retreated to lower altitudes and latitudes when the Ice Sheet approached its most southern limit. If we were to maintain, on the other hand, that Lower Austral plants had survived the Glacial Epoch in the Appalachian region, we should be compelled to assume that species which had developed under the mild climatic conditions generally believed to have prevailed, even in high northern latitudes, during Miocene and Pliocene times, later adapted themselves to the considerably lower temperatures prevailing during the comparatively brief Glacial Epoch, and, after the close of that Epoch, readjusted themselves to the warmer temperatures which again held sway.‡

* Thus J. D. Whitney, who goes much farther than most geologists in reaction against previously entertained ideas as to the extent and importance of the Ice Sheet, remarks as follows in his well known paper on 'The Climatic Changes of Later Geological Times' (Contr. to Amer. Geology, Harvard University, Vol. 2, p. 268, 1888): "A general refrigeration of the earth could never have caused that peculiar distribution of snow and ice to which the term Glacial Epoch is commonly applied; and * * * the phenomena in question are entirely compatible with a higher mean temperature than now prevails." Again (p. 321): "We have no right to assume as having existed during the Glacial Epoch a period of intense cold, or even a lower mean temperature than that now prevailing over the earth." And (p. 387): "It is possible to lay aside all idea of explaining the phenomena of the so-called Glacial Epoch, by referring them to the extension of a general or Polar ice-cap over the land of the Northern Hemisphere. * * * The entire body of facts presented brings out most clearly the true condition of things, namely that the Glacial Epoch was a local phenomenon, during the occurrence of which much the larger part of the land-masses of the globe remained climatologically entirely unaffected." This author represents, however, an extreme view, which is rejected by many geologists.

† 'Das Klima der Eiszeit'; Sitzungsber. d. naturw. Gesellsch. Isis in Dresden, 1883, pp. 56, 57 (1884).

* A. C. Seward, in discussing 'Fossil Plants as Tests of Climate' (London, 1892), p. 50, after summing up the evidence *pro* and *con* which has been brought forward to prove that forests could have maintained themselves amid or very near the great glacier, decides against the possibility of such survival. On the other hand, we have no right to assume that a vigorous forest growth may not have continued to flourish in the greater part of the Appalachian region, at least at low elevations, throughout the Glacial Epoch. For, as the same author remarks, pines and even tree ferns thrive to-day at the very edge of the terminal moraines of New Zealand glaciers; while, in Alaska, some glaciers (notably the Malaspina) are largely covered with spruce, alder and other trees.

† The area supposed to have been covered by the Ice Sheet in North America has been mapped by Professor T. C. Chamberlin; 7th Ann. Rep. U. S. Geol. Survey, pl. 8 (1888).

‡ It will be objected that it is not always safe to argue from the present requirements of organisms (especially of genera and still larger groups), the

The difficulty of such an assumption is increased by the fact that some of the forms belonging to our second category have apparently undergone little modification since Pliocene times; and this may well be true of many of them whose past history is still unknown. To the average mind, the alternative hypothesis, that of an extensive migration of the less resistant species from the mountains to the warmer lowlands, is decidedly more thinkable.

As the Ice Sheet began to recede, and the climate of the Appalachian Region became gradually milder, approaching its present character, those species which had resided in the Appalachian Region before the Pleistocene, would have gradually returned thither; but as the climate of to-day is probably considerably colder than that of the Pliocene, it is to be presumed that this floral element now occurs at a lower altitude than that at which it flourished in pre-Glacial times. It may be assumed, furthermore, that the neo-tropical forms which constitute our first category, then began to make their way, for the first time, into the Appalachian Region.

To account for the presence to-day of representative species of certain genera (*e. g.*, *Stuartia*, *Fothergilla*) in the mountains and in the Coastal Plain, respectively, it is conceivable that after the final retreat of the great glacier, the increasing heat of the lowlands induced in some individuals of a single ancestral species, which had sought refuge there during the Ice Age, changes of physiological constitution and of structure which fitted them to endure a warmer climate than that to which they had previously been accustomed. Other individuals having gradually made their way to higher elevations on the heels of the retreating Boreal flora, settled finally in the valleys and on the lower slopes of the mountains, where they have remained up to the present day, perhaps with little variation from the Pliocene form.

If we assume, on the other hand, that forms contained in our list of representative species were enabled to survive the Glacial Epoch without migrating, *in toto*, from the Appalachian Region, an alternative hypothesis becomes possible.

In that case it may be conceived that while some individuals of each hypothetical Pliocene ancestral species maintained themselves in well-sheltered situations and were not forced to a change of abode, others escaped the changing environment by a gradual retreat into the warmer lowlands. The individuals which remained in the mountains were the direct ancestors of the present Appalachian species; while those which migrated and later accustomed themselves in the Coastal Plain to the increasing temperatures that ensued upon the close of the Glacial Epoch, gave rise to the Austro-riparian species that attract our attention to-day because of their close resemblance to Appalachian forms.*

It is true that this theory leaves unexplained the occurrence, both in mountains and plain, of identical species of the second

climatic conditions to which they have previously been adapted. This point is well brought out by H. von Ihering in a paper on 'Die neotropische Tropengebeit und seine Geschichte' (Engler Bot. Jahrb., vol. 17, Beiblatt 42, 1893). It is easily conceivable, for example, that vegetation as a whole has been accustoming itself, during long ages, to gradually decreasing heat. But, in the case which we are here considering, this objection cannot be allowed much weight, as the climatic changes have been more or less oscillatory, rather than progressive and have taken place within a (geologically speaking) comparatively brief period.

* It is not impossible that in some of these cases of representative species, differentiation of the allied forms may have taken place before the advent of the Glacial Epoch. But in most instances the relationship is so extremely close that we need not assume for them an older origin, especially as no other convenient hypothesis offers to account for their present distribution.

category, including such woody plants as *Decumaria*, *Itea*, *Callicarpa*, *Oxydendrum*, *Aralia spinosa*, *Vitis rotundifolia*, etc. A similar case is the presence of *Azalia viscosa*, an essentially Coastal Plain species, here and there in the mountains along with its mountain analogue, *A. arborescens*. *Leucothoë racemosa*, abundant in the swamps of the seaboard, is also found occasionally along highland streams, while a closely related and very similar species, *L. recurva*, is much more abundant in the mountains, to which it is confined. These are cases where the differentiation in distribution of corresponding forms, one in the Coastal Plain, and another in the Appalachian region, is either incomplete or has not taken place at all. But as no fact in biology is better known than the capacity of some species to endure a wide range of physical conditions, while others are fatally sensitive to comparatively slight differences of environment, this difficulty is not an insuperable one.

The initial appearance in the mountains of species of the first category, *i. e.*, those of presumably neotropical origin, was probably somewhat subsequent to the return thither of the Miocene Boreal forms of the second category, for most of the former require decidedly higher temperatures than many of the latter. But we know little of the history of such groups as are chiefly represented in this category and which make up a large part of the modern tropical American flora, *i. e.*, the above mentioned tribes of Gramineæ, Leguminosæ and Compositæ. Hence we must content ourselves with assuming that these species did not exist in the Appalachian region prior to recent geologic time, and that they constitute the most modern element of its flora.

It is more than probable that the hypothesis just outlined is very incomplete as to details and will be found not to account for all the phenomena. Instead of the comparatively simple progression of events which it premises, the fact is pretty well established that there was more than one advance and recession of the Ice Sheet, and that the mutations of the flora have been correspondingly intricate. But of the complex of factors which have been at work since the middle of the Tertiary in giving to this flora its present distribution, we know far too little to permit the elaboration of a more comprehensive theory. Until we possess a much larger body of paleontological evidence, and a better understanding of past climatic conditions, we must be content with some such working hypothesis.

When we come to inquire into the conditions of climate and of soil which permit the actual existence of numerous Lower Austral forms in juxtaposition to a Transition and even Canadian flora, we enter upon an investigation that is within the domain of exact research. Here we are dealing with things tangible, which can to some extent be weighed and measured.

First let us compare the climate of the Appalachian Region in the Southern States with that which prevails under the same latitude in the Austro-riparian area, directing our attention to the factors of temperature which have the largest effect in determining the zonal distribution of organisms. These are believed to be: (1) the normal number of days during the year which possess a temperature above 6° C. (43° F.); (2) the normal sum total of temperatures above 6° C. during the period thus defined;* and (3) the normal mean of the six consecutive hottest weeks.† In the following table data are given for four stations in the mountain region and for two of

* The factor which is believed to fix the northern and upper limit of the great life zones. See Merriam in *Nat. Geogr. Mag.*, 6 : 229–238, 1894. Also Life Zones and Crop Zones, Bull. Div. Biol. Survey, U. S. Dept. Agric., 10 : 54, 1898.

† The factor taken as determining the southern and lower limit of the zones, Merriam, l. c.

the most northern in the Austro-riparian area.

The Highlands station is cited here for the sake of comparison, but does not otherwise answer our purpose, its elevation being so great as to preclude the occurrence at Norfolk. In short, Norfolk temperatures are farther below those of Memphis, than Valley Head temperatures are below those of Norfolk. The occurrence of many Austro-riparian species at Valley Head is therefore small matter for wonder. But in order

STATION.	Altitude.	Days with temperature above 6°C. (43°F.).	Sum total above 6°C. (43°F.).	Normal Mean of 6 hottest weeks.
Highlands, N. C.	3817 ft.	234	1970.5°C. (3547°F).	18.9°C. (66.1°F).
Asheville, N. C.	1981–2250 ft.	249	2604.5°C. (4688°F).	21.8°C. (71.3°F).
Knoxville, Tenn.	891–933 ft.	267	3090.5°C. (5563°F).	24.5°C. (76.1°F).
Valley Head, Ala.	1027 ft.	293	3049.0°C. (5488°F).	24.0°C. (75.2°F).
Norfolk, Va.	11–12 ft.	295	3359.5°C. (6047°F).	26.3°C. (79.3°F).
Memphis, Tenn.	117–273 ft.	307	3752.2°C. (6754°F).	27.2°C. (81°F).

of any important number of Lower Austral species. Knoxville falls slightly below the minimum altitude to which this discussion was limited at the outset; but owing to its proximity to some of the most interesting colonies described above, and in the absence of the requisite data from points lying nearer them, it has seemed best to give it place in the table. The most useful data are those given for Asheville and for Valley Head. Both have an altitude of more than 300 meters (1,000 feet) above the sea, and at both points a considerable number of Austro-riparian forms is known to occur.

At Asheville the normal sum total of effective heat is only about 80 per cent. of that at Norfolk, and slightly more than 66 per cent. of that at Memphis. The normal number of days of the year possessing physiologically effective temperatures is, at Asheville, about 85 per cent. of that at Norfolk, and about 82 per cent. of that at Memphis. At Valley Head, which is only about one-half as high as Asheville, and is considerably farther south, the normal sum total of heat stands to that of Norfolk in about the ratio of 11 to 12; and, to that at Memphis nearly as 4 to 5. The normal number of days of the year whose temperature exceeds 6° C. is only two less than to explain their presence at Asheville, and at other points along the French Broad River at elevations of 330 to 600 meters (1,100 to 2,000 feet),* where we find the temperature conditions as ordinarily expressed so different from those of the Austro-riparian area proper, other elements of the *milieu* must be brought into consideration. The two factors which are probably most effective in permitting those species to maintain themselves in what would seem to be an unfriendly environment are: (1) The amount of insolation; and (2) The nature of the soil.

1. *Insolation.* — A favorite situation in the mountains for colonies of Lower Austral species is on the southern exposure of hills, where the angle of inclination and the position with reference to the sun insure the greatest possible amount of insolation. The duration and intensity of the heat and light which such exposures receive from the sun on summer days must go far towards counterbalancing the effect of altitude in lowering the temperature during the hours of darkness, and in shortening the growing season. The flora of the Coastal Plain

* At Biltmore, N. C., with an altitude of 1,993 to 2,150 feet, occur *Arundinaria macrosperma*, *A. tecta*, *Hypericum virgatum*, *Helenium nudiflorum* and several other characteristic Lower Austral species.

under the same latitudes, while favored by the low elevation of the country, is less advantageously situated in that it does not usually receive the greatest possible force of the sun's rays during the hottest weeks of summer.

2. *Soil.* — The soil preferred by the great majority of Austro-riparian plants which are met with in the mountains, especially those of our first category, which are assumed to be of neo-tropical origin, is light, sandy and poor in organic matter ; consequently readily permeable to water and becoming quickly and strongly heated. It is very similar to the soils which cover a great part of the Coastal Plain. In a substratum of this character, whether on the lower slopes or in the river bottoms, we invariably find established the larger colonies of Lower Austral species. In consonance with their environment, most of them are xerophytic or hemi-xerophytic in structure, as is the case with a great portion of the vegetation of the coastwise pine-barrens.

On the heavier and consequently colder and wetter soils, and on slope exposures other than southern, the flora is always of predominately Transition character, at the same elevation or even, in places, descending to lower altitudes than are often reached on the opposite slope by Carolinian and Austro-riparian forms.

Unfortunately no investigations have yet been made in this mountain region which afford us exact data as to the amount of isolation received by plants growing in the situations described; nor have we the measurements of soil temperature which are necessary to the further prosecution of the present inquiry. A comparative study of this question in various parts of the Appalachian region and of the Coastal Plain, coupled with an investigation of the ecology of the vegetation along anatomical-physiological lines, would beyond all doubt yield results of the greatest interest and value. It is earnestly hoped that such an investigation can be undertaken in the nea future.

THOS. H. KEARNEY, JR.

SCIENTIFIC BOOKS.

Gauss and the non-Euclidean Geometry. CARL FRIEDRICH GAUSS WERKE. Band VIII. Göttingen. 1900. 4to. Pp. 458.

We are so accustomed to the German professor who does, we hardly expect the German professor who does not.

Such, however, was Schering of Göttingen, who so long held possession of the papers left by Gauss.

Schering had planned and promised to publish a supplementary volume, but never did, and only left behind him at his death certain preparatory attempts thereto, consisting chiefly of excerpts copied from the manuscripts and letters left by Gauss. Meantime these papers for all these years were kept secret and even the learned denied all access to them.

Schering dead, his work has been quickly and ably done, and here we have a stately quarto of matter supplemental to the first three volumes, and to the fourth volume with exception of the geodetic part.

Of chief interest for us is the geometric portion, pp. 159–452, edited by just the right man, Professor Staeckel of Kiel.

One of the very greatest discoveries in mathematics since ever the world began is, beyond peradventure, the non-Euclidean geometry.

By whom was this given to the world in print?

By a Hungarian, John Bolyai, who made the discovery in 1823, and by a Russian, Lobachévski, who had made the discovery by 1826.

Were either of these men prompted, helped, or incited by Gauss, or by any suggestion emanating from Gauss?

No, quite the contrary.

Our warrant for saying this with final and overwhelming authority is this very eighth volume of Gauss's works, just now at last put in evidence, published to the world.

The geometric part opens, p. 159, with

Gauss's letter of 1779 to Bolyai Farkas the father of John (Bolyai János), which I gave years ago in my Bolyaí as demonstrative evidence that in 1799 Gauss was still trying to prove Euclid's the only non-contradictory system of geometry, and also the system of objective space.

The first is false; the second can never be proven.

But both these friends kept right on working away at this impossibility, and the more hotheaded of the two, Farkas, finally thought he had succeeded with it, and in 1804 sent to Gauss his 'Göttingen Theory of Parallels.' Gauss's judgment on this is the next thing given (pp. 160–162). He shows the weak spot. "Could you *prove*, that $dkc = ckf = fkg$, etc., then were the thing perfect. However, this theorem is indeed true, only difficult, without already presupposing the theory of parallels, to prove rigorously." Thus in 1804 instead of having or giving any light, Gauss throws his friend into despair by intimating that the link missing in his labored attempt is true enough, but difficult to prove without petitio principii.

Of course we now know it is *impossible* to prove.

Anything is impossible to prove which is the equivalent of the parallel postulate.

Yet both the friends continue their strivings after this impossibility.

In this very letter Gauss says: "I have indeed yet ever the hope that those rocks sometime, and indeed before my end, will allow a through passage."

Farkas on December 27, 1808, writes to Gauss: "Oft thought I, gladly would I, as Jacob for Rachel serve, in order to know the parallels founded even if by another.

"Now just as I thought it out on Christmas night, while the Catholics were celebrating the birth of the Saviour in the neighboring church, yesterday wrote it down, I send it to you enclosed herewith.

"To-morrow must I journey out to my land, have no time to revise, neglect I it now, may be a year is lost, or indeed find I the fault, and send it not, as has already happened with hundreds, which I as I found them took for genuine. Yet it did not come to writing those down, probably because they were too long, too difficult, too artificial, but the present I wrote off at once. As soon as you can, write me your real judgment."

This letter Gauss never answered, and never wrote again until 1832, a quarter of a century later, when the non-Euclidean geometry had been published by both Lobachévski and Bolyai János.

This settles now forever all question of Gauss having been of the slightest or remotest help or aid to young János, who in 1823 announced to his father Farkas in a letter still extant, which I saw at the Reformed College in Maros-Vásárhely, where Farkas was professor of mathematics, his discovery of the non-Euclidean geometry as something undreamed of in the world before.

This immortal letter, a charming and glorious outpouring of pure young genius, speaks as follows:

"Temesvár 3 Nov., 1823.

"My dear and good father,

"I have so much to write of my new creations, that it is at the moment impossible for me to enter into great detail, so I write you only on a quarter of a sheet. I await your answer to my letter of two sheets; and perhaps I would not have written you before receiving it, if I had not wished to address to you the letter I am writing to the Baroness, which letter I pray you to send her.

"First of all I reply to you in regard to the binominal.

* * * * * *

"Now to something else, so far as space permits. I intend to write, as soon as I have put it into order, and when possible to publish, a work on parallels. At this moment it is not yet finished, but the way which I have hit upon promises me with certainty the attainment of the goal, if it in general is attainable. It is not yet attained, but I have discovered such magnificent things that I am myself astonished at them.

"It would be damage eternal if they were lost. When you see them, my father, you yourself will acknowledge it. Now I cannot say more of them, only so much: *that from nothing I have created another wholly new world.*

All that I have hitherto sent you compares to this only as a house of cards to a castle.

"P. S. I dare to judge absolutely and with conviction of these works of my spirit before you, my father; I do not fear from you any false interpretation (that certainly I would not merit), which signifies that, in certain regards, I consider you as a second self."

In his autobiography János says: "First in the year 1823 did I completely penetrate through the problem according to its essential nature, though also afterward further completions came thereto. I communicated in the year 1825 to my former teacher, Herrn Johann Walter von Eckwehr (later imperial-royal general), a written paper, which is still in his hands. On the prompting of my father I translated my paper into Latin, in which it appeared as *Appendix* to the *Tentamen* in 1832."

So much for Bolyai.

The equally complete freedom of Lobachévski from the slightest idea that Gauss had ever meditated anything different from the rest of the world on the matter of parallels I showed in SCIENCE, Vol. IX., No. 232, pp. 813–817.

Passing on to the next section, pp. 163–164, in the new volume of Gauss, we find it important as showing that in 1805 Gauss was still a baby on this subject. It is an erroneous pseudo-proof of the impossibility of what in 1733 Saccheri had called 'hypothesis anguli obtusi.' To be sure Saccheri himself thought he had proved this hypothesis inadmissible, so that Gauss blundered in good company; but his pupil Riemann in 1854 showed that this hypothesis gives a beautiful non-Euclidean geometry, a new universal space, now justly called the space of Riemann.

Passing on, we find that in 1808, Schumacher writes: "Gauss has led back the theory of parallels to this, that if the accepted theory were not true, there must be a constant *à priori* line given in length, which is absurd. Yet he himself considers this work still not conclusive."

Again, with the date April 27, 1813, we read: "In the theory of parallels we are even now not farther than Euclid was. This is the partie honteuse (shameful part) of mathematics, which soon or late must receive a wholly different form."

Thus in 1813 there is still no light.

In April, 1816, Wachter, on a visit to Göttingen, had a conversation with Gauss whose subject was what he calls the anti-Euclidean geometry. On December 12, 1816, he writes to Gauss a letter which shows that this anti-Euclidean geometry, as he understands it, was far from being the non-Euclidean geometry of Lobachévski and Bolyai János.

The letter as here given by Staeckel, pp. 175–176, is as follows:

* * * "Consequently the anti-Euclidean or your geometry would be true. However, the *constant* in it remains undetermined: why? may perhaps be made comprehensible by the following:

"* * * The result of the foregoing may consequently be so expressed:

"The Euclidean geometry is false; but nevertheless the true geometry must begin with the same eleventh Euclidean axiom or with the assumption of lines and surfaces which have the property presumed in that axiom.

"Only instead of the straight line and plane are to be put the great circle of that sphere described with infinite radius together with its surface.

"From this comes indeed the one inconvenience, that the parts of this surface are merely symmetric, not, as with the plane, congruent; or that the radius out on the one side is infinite, on the other imaginary. Only it is clear how that inconvenience is again overbalanced by many other advantages which the construction on a spherical surface offers; *so that probably also then even*, if the Euclidean geometry were true, the necessity no longer indeed exists to consider the plane as an infinite spherical surface, though still the fruitfulness of this view might recommend it.

"Only, as I thought through all this, as I had already fully satisfied myself about the result, in part since I believed I had recognized the ground (la métaphysique) of that indeterminateness necessarily inherent in geometry—also even the complete indecision in this matter, then, if that proof against the Euclidean geometry, as I could not expect, were not to be considered as stringent; in part, so not to consider as lost all the many previous researches in plane

geometry, but to be used with a few modifications, and that still also the theorems of solid geometry and mechanics might have approximate validity, at least to a quite wide limit, which perhaps yet could be more nearly determined; I found this evening, just while busied with an attempt to find an entrance to your transcendental trigonometry, and while I could not find in the plane sufficing determinate functions thereto, going on to space constructions, to my no small delight the following *demonstration for the Euclidean parallel theory.* * * *

"* * * Just in the idea to conclude I remark still, that the above proof for the Euclidean parallel-theory is fallacious. * * * Consequently has here also the hope vanished, to come to a fully decided result, and I must content myself again with the above cited. Withal I believe I have made upon that way at least a step toward your transcendental trigonometry, since I, with aid of the spherical trigonometry, can give the ratios of all constants, at least *by construction of the right-angled triangle.* I yet lack the actual reckoning of the base of an isosceles triangle from the side, to which I will seek to go from the equilateral triangle."

As to Gauss's transcendental trigonometry, nothing was ever given about it but its name. *Requiescat in pace.*

Yet Gauss writes, April 28, 1817:

"Wachter has printed a little piece on the foundations of geometry.

"Though Wachter has penetrated farther into the essence of the matter than his predecessors, yet is his proof not more valid than all others."

We come now to an immortal epoch, that of the discovery of the real non-Euclidean geometry by Schweikart, and his publication of it under the name of Astral-Geometry.

On the 25th of January, 1819, Gerling writes to Gauss:

"Apropos of parallel-theory I must tell you something, and execute a commission. I learned last year that my colleague Schweikart (prof. juris, now Prorector) formerly occupied himself much with mathematics and particularly also had written on parallels.

"So I asked him to lend me his book. While he promised me this, he said to me that now indeed he perceived how errors were present in his book (1808) (he had, for example, used quadrilaterals with equal angles as a primary idea), however that he had not ceased to occupy himself with the matter, and was now about convinced that without some datum the Euclidean postulate could not be proved, also that it was not improbable to him that our geometry is only a chapter of a more general geometry.

"Then I told him how you some years ago had openly said that since Euclid's time we had not in this really progressed; yes, that you had often told me how you through manifold occupation with this matter had not attained to the proof of the absurdity of such a supposition. Then when he sent me the book asked for, the enclosed paper accompanied it, and shortly after (end of December) he asked me orally, when convenient, to enclose to you this paper of his, and to ask you in his name to let him know, when convenient, your judgment on these ideas of his.

"The book itself has, apart from all else, the advantage that it contains a copious bibliography of the subject; which he also, as he tells me, has not ceased still further to add to."

Now comes, pp. 180–181, the precious enclosure, dated Marburg, December, 1818, which, though so brief, may fairly be considered the first *published* (not printed) treatise on non-Euclidean geometry.

It is a pleasure to give this here in English for the first time.

The non-Euclidean Geometry of 1818: By SCHWEIKART.

"There is a two-fold geometry—a geometry in the narrower sense—the Euclidean, and an astral science of magnitude."

The triangles of the latter have the peculiarity, that the sum of the three angles is not equal to two right angles.

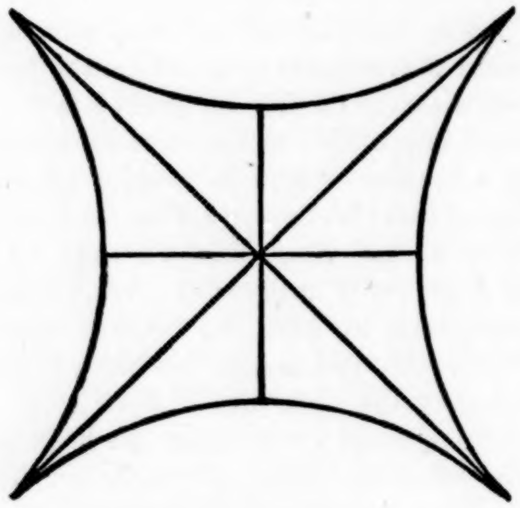
This presumed, it can be most rigorously proven:

(*a*) That the sum of the three angles in the triangle is *less* than two right angles;

(*b*) That this sum becomes ever smaller, the more content the triangle encloses;

(*c*) That the altitude of an isosceles right-angled triangle indeed ever increases, the more one lengthens the side; that it, however, cannot surpass a certain line, which I call the *constant.*

Squares have consequently the following form:



Is this constant *for us* half the earth's axis (as a consequence of which each line drawn in the universe from one fixed star to another, which are ninety degrees apart from one another, would be a tangent of the earth-sphere), so is it in relation to the spaces occurring in daily life infinitely great.

The Euclidean geometry holds good only under the presupposition that the constant is infinitely great. Only then is it true that the three angles of every triangle are equal to two right angles; also this can be easily proved if one takes as given the proposition that the constant is infinitely great.

Such is the brief declaration of independence of this hero.

Nor were Schweikart's courage and independence without farther issue. Under his direct influence his own nephew, Taurinus, developed the real non-Euclidean trigonometry and published it in 1825, with successful applications to a number of problems.

Moreover, this teaching of Schweikart's made converts in high places.

In the letter of Bessel to Gauss of 10 Feb., 1829 (p. 201), he says: "Through that which Lambert said, and what Schweikart disclosed orally, it has become clear to me that our geometry is incomplete, and should receive a correction, which is hypothetical and, if the sum of the angles of the plane triangle is equal to a hundred and eighty degrees, vanishes.

"That were the *true* geometry, the Euclidean the *practical*, at least for figures on the earth."

The complete originality and independence of Schweikart and of Lobachévski are recognized as a matter of course in the correspondence between Gauss and Gerling, who writes, p. 238: "The Russian steppes seem, therefore, indeed a proper soil for these speculations, for Schweikart (now in Königsberg) invented his 'Astral-Geometry' while he was in Charkow."

This fixes the date of the first conscious creation and naming of the non-Euclidean geometry as between 1812 and 1816.

Gauss adopts and uses for himself this first name, Astral-Geometry (1832, p. 226; 1841, p. 232).

At length the true prince comes. On February 14, 1832, Gauss receives the profound treatise of the young Bolyai János, the most marvellous two dozen pages in the history of thought. Under the first impression Gauss writes privately to his pupil and friend Gerling of the ideas and results as 'mit grosser Eleganz entwickelt.' He even says 'I hold this young geometer von Bolyai to be a genius of the first magnitude.'

Now was Gauss's chance to connect himself honorably with the non-Euclidean geometry, already independently discovered by Schweikart, by Lobachévski, by Bolyai János.

Of two utterly worthless theories of parallels Gauss had already given extended notices in in the *Göttingische gelehrte Anzeigen* (this volume, pp. 170–174 and 183–185).

To this marvel of János, Gauss vouchsafed never one printed word.

As Staeckel gently remarks, this certainly contributed thereto, that the worth of this mathematical gem was first recognized when John had long since finished his earthly career.

The 15th of December, 1902, will be the centenary of the birth of Bolyai János.

Should not the learned world endeavor to arouse the Magyars to honor Hungary by honoring then this truest genius her son?

George Bruce Halsted.
Austin, Texas.

SCIENTIFIC JOURNALS AND ARTICLES.

In the July number of the *American Journal of Insanity*, Dr. J. G. Rogers, of Indiana, pre-

sents an article entitled 'A Century of Hospital Building for the Insane,' which is worthy of much attention. He favors the erection of buildings which will permit classification into separated groups, not less than sixteen and twenty are preferable. The common dining-hall and the common kitchen are commended on the score of economy. Details follow in regard to methods and materials of construction, lighting, ventilation, etc.

Special provision should be made for certain classes of the insane, such as farm colonies for a working class, separate buildings for tubercular patients and infirmary buildings for the harmless and helpless.

Dr. C. A. Good, of Michigan, gives a 'Review of Chronic Progressive Chorea (Huntington's), with Report of a Case.' In the case reported excellent lithographs are given of microscopic sections which demonstrate degenerative changes in the muscles; pigment granules within the cells of the posterior root ganglion; and cysts and cell degeneration in the cerebral cortex.

Dr. H. J. Berkley, of Baltimore, reports a fatal case of dementia paralytica from a multiple thrombosis of bacterial origin. The theory is advanced that the thrombosis of the cerebral vessels was due to changes in the blood induced by toxic products, as well as from the presence of bacteria in such numbers as to form a nidus for a blood coagulation.

Dr. C. W. Pilgrim, of Poughkeepsie, in a paper entitled 'The Study of a Year's Statistics' gives interesting conclusions respecting patients under treatment at the Hudson River State Hospital. Of the patients admitted during the year, 41.5 per cent. presented symptoms of melancholia; 32.5 per cent. presented symptoms of mania; 20 per cent. were cases of dementia and 6 per cent. had dementia paralytica. Among those admitted 30 per cent. recovered during the year or had prospects of recovery; 12 per cent. were improved; 11 per cent. died and 47 per cent. were chronic cases when they came to the hospital and probably will die uncured. Some interesting statistics are given concerning the months during which deaths were most frequent: 61 per cent. of deaths occurred between October and April and 39 per cent. only between April and October. The 'hour of death' showed that 26 per cent. died between midnight and 6 A. M.; 19 per cent., between 6 A. M. and noon; 31 per cent. between noon and 6 P. M., and 24 per cent. between 6 P. M. and midnight.

Dr. A. H. Harrington, of Danvers, Massachusetts, believes that 15 per cent. of all deaths in hospitals for the insane in the United States are due to tuberculosis, and declares it to be "the duty of the State to provide its hospitals with the means of taking care of its tuberculous insane in such a manner as shall prevent the infection of the non-tubercular, and also give the necessary care to those suffering from the disease."

Dr. C. P. Bancroft, of Concord, New Hampshire, discusses the trial and conviction of Bradford P. Knight, of Augusta, Maine, who committed an atrocious murder while evidently insane, and who, although declared guilty of murder in the first degree, was prior to sentence transferred to a hospital for the insane. The jury returned the only possible verdict under the explicit charge of the presiding judge, which was based upon the erroneous idea that legal insanity differs in some mysterious manner from medical insanity; in other words, that the presence of insanity does not necessarily preclude responsibility for actions.

Dr. P. M. Wise, of New York, traces the steps which have been taken in the creation and development of the Pathological Institute of the New York State hospitals, and mentions the difficulties which have been encountered in the prosecution of the work.

'Suicide and its Increase' is the title of a paper by G. Styles, of Michigan, which presents the following suggestive statistics:

Forty years ago it was shown that while only 4 in every 10,000 persons rated as paupers died by their own hands, nearly 7 coachmen or other servants, 5 bankers or professional men, 7.8 dragoons, 7.43 tailors, shoemakers and bakers, while the trades making the best showing (1.33) were carpenters, butchers and masons. Of the countries concerned, Sweden has the lowest average, only 1 to 92,000; Russia, 1 to 35,000; the United States, 1 to 15,000; Saxony, 1 to 8,446; while in the cities of St. Petersburg

and London, England, the proportion was 1 to 21,000. Taking the last fifty years, we find that for every 100,000 inhabitants of France there were, from 1841–45, 9 suicides; from 1846–50, 10; from 1861–70, 13; from 1871–75, 15; from 1876–80, 17; for 1889, 21; for 1893, 22; for 1894, 26. Durkheim shows that from 1826 to 1890 the number of suicides in Belgium increased 72 per cent.; in Prussia, 411 per cent.; in Austria, 238 per cent.; in France, 318 per cent.; in Saxony, 212 per cent., while in Sweden and Denmark the increase has been the lowest, viz., 72 and 35, respectively. That religion seems to wield an important influence in connection with self-murder is evident from the fact that in Roman Catholic communities suicide is less prevalent."

THE *Journal of Physical Chemistry*, November, 'On the Solubility of Manganous Sulphate,' by F. G. Cottrell. A determination of the solubility of the hydrates containing 1, 4, 5 and 7 molecules of water of crystallization—no other hydrates were found. The salt of commerce is sometimes that with four, sometimes that with five molecules of water. 'Catalysis and Chemical Energy,' by Oscar Loew. In catalysis "it is the oscillations of the free heat energy of the atmosphere which are modified by certain peculiarities of the platinum atom in such a manner that they can pass still more easily than they usually do into the oscillations of chemical energy. The catalytic action of certain organic compounds is due to the chemical energy of labile atoms." 'The Reaction between Chloroform and Potassium Hydroxide,' by A. P. Saunders. In all probability the action proceeds in stages, in each of which only two molecules react together. 'Vapor-Pressure Relations in Mixtures of Two Liquids, III,' by A. Ernest Taylor. Attention may well be called to the fact that to almost every article contained in this *Journal* since its inception is appended a brief summary of the results obtained and conclusions drawn. It would be a great advantage if this practice prevailed in all our scientific journals.

THE Medical Society of New York University has planned the establishment of a quarterly journal to be called *The New York University Bulletin of the Medical Sciences* and to be edited by a committee of the Society under the business management to be designated by the University. The contents of the Bulletin are to be: (1) Original articles directly contributed to the bulletin. (2) Abstracts or *extenso* reproductions of articles originally published elsewhere. (3) Short communications made at the meetings of the Medical Society. (4) Brief minutes of those meetings. (5) Reports on methods devised or tested in the departments of the medical college. (6) A reference list of publications by those connected with the medical college.

SOCIETIES AND ACADEMIES.

NATIONAL ACADEMY OF SCIENCES.

At the winter meeting of the National Academy of Sciences, held at Brown University, Providence, R. I., on November 13, 14 and 16, the following program was presented:

I. 'Investigations of Light and Electricity with the Aid of a Battery of Twenty Thousand Cells,' by J. Trowbridge.

II. 'Progressive Evolution of Characters in the Young Stages of Cephalopods,' by Alpheus Hyatt.

III. 'Descriptive Method of Presenting the Phenomena of the Cycle of Evolution among Cephalopods,' by Alpheus Hyatt.

IV. 'The Porous Cup Voltameter,' by T. W. Richards.

V. 'An Account of the Study of Growing Crystals by Instantaneous Microphotography,' by T. W. Richards.

VI. 'Stereographic Projection and Some of its Possibilities from a Graphical Standpoint,' by S. L. Penfield.

VII. 'On the Development of the Pig,' by C. S. Minot.

VIII. 'Normal Plates illustrating the Development of the Rabbit and the Dogfish,' by C. S. Minot.

IX. 'Note on the Energy of Recent Earthquakes,' by T. C. Mendenhall.

X. 'Spectrum of Sodium in a Magnetic Field,' by A. A. Michelson.

XI. 'A Report of the Spectrum Work carried on with the Aid of a Grant from the Bache Fund,' by H. A. Rowland.

XII. 'On the Explanation of Inertia and Gravitation by Means of Electrical Phenomena,' by H. A. Rowland.

XIII. 'Distribution and Phylogeny of Limulus,' by A. S. Packard.

XIV. 'Male Preponderance (Androrhopy) in Lepidopterous Insects,' by A. S. Packard.

XV. 'The Synthesis and Reactions of Sodium Acetate Ester, and their Relation to a New Interpretation of Chemical Metathesis,' by A. Michael.

XVI. 'On the Genesis of Matter,' by A. Michael.

XVII. 'Demonstration of the Projection of One Grating by Another,' by C. Barus.

XVIII. 'Exhibition of Certain Novel Apparatus; A Wave Machine; An Expansion Lens; A Recording System of Two Degrees of Freedom; A Tube Showing Colored Cloudy Condensation,' by C. Barus.

XIX. 'On Stability of Vibration and on Vanishing Resonance,' by C. Barus.

XX. 'Hysteresis-like Phenomena in Torsional Magnetostriction and their Relation to Viscosity,' by C. Barus.

XXI. 'Progress in the Echelon Spectroscope,' by A. A. Michelson.

XXII. 'Report on the Meeting of the International Association of Academies held at Paris, July 31, 1900,' by J. M. Crafts.

NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE regular meeting of the New York Section of the American Chemical Society was held October 5th at the Chemists' Club.

The following papers were read: 'Dr. Meyer's Tangent System of Sulphuric Acid Manufacture,' by C. Glazer; 'Note on the Determination of Zinc in the Franklin, New Jersey, Ores by the Ferrocyanide Method,' by Wm. H. Bassett.

The chair appointed C. Richardson, P. de P. Ricketts and M. Loeb a committee on prizes.

M. T. BOGERT,
Sec'y pro tem.

AT the meeting on November 9th, Dr. C. A. Doremus presided and over fifty members were present. 'A Brief Review of Antipyrine and its more Important Derivatives,' was the subject of a paper by D. C. Eccles. Referring to the matter of papers to be read before the Section during the season, Dr. McMurtrie said that every chemist actively engaged in any subject could bring topics before the Section, which would be of great interest to others, and of no less interest because of not being in shape for publication in the journal. And, further, he urged the members to realize that interesting meetings required that each should furnish his share of the work.

The chairman, Dr. Doremus, said he thought the opportunity of bringing their work before the Society was not appreciated by the younger members, who had better seek the opportunity in their own interest than wait for invitation.

Special announcement was made of the death of Dr. E. R. Squibb, so long an enthusiastic member and active co-worker in the Society. Personal reminiscences were given by Dr. Rice and by Messrs. Bogert, McMurtrie, Breneman, Eccles and Doremus.

It was moved and seconded that a committee be appointed to draw up suitable resolutions expressing the Society's appreciation of Dr. Squibb's character, of his services to chemical science, and of the loss sustained by the Society in his death. And, further, that the resolutions should be engrossed in duplicate—a copy to be sent to his family and one to be preserved by the Society.

DURAND WOODMAN,
Secretary.

NEW YORK ACADEMY OF SCIENCES.
SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

A MEETING of the Section was held on November 5th, at 12 West 31st Street, New York.

A paper was read by Dr. F. L. Tufts, of Columbia University, on 'The Flow of Air through Granular Materials at Different Pressures.' These experiments were made in connection with others on the transmission of sound through the same materials. Three different materials were experimented on, composed of lead shot of three sizes, the diameters of the shot being respectively 4.37 mm., 2.79 mm., and 1.22 mm. The shot was placed in a tube and air was forced through at different pressures, the rate of flow of air being measured by a gas meter and the pressure differences by a water manometer. It was found that for a given size of shot and a given pressure gradient, the rate of flow was independent of the length of the column of shot through which the air flowed. The rate of flow, however, in the three cases experimented with, did not increase

as rapidly as the pressure gradient. This was more noticeable with the coarse shot than with the finer. For pressure gradients of about 0.01 cm. of water pressure per centimeter of length of material, the rate of flow through the coarsest shot was ten times the rate through the finest, while for a pressure gradient fifty times as great the rate of flow was a little less than three times as great in the coarsest as in the finest. With each size of shot the space occupied by air was about 39 per cent. of the total space occupied by the shot.

WM. S. DAY,
Sec'y of Section.

DISCUSSION AND CORRESPONDENCE.

A DISCLAIMER.

THE attention of the undersigned has been called to the fact that an organization known as 'The American College of Sciences,' situated in Philadelphia, is issuing circulars advertising a course of instruction in hypnotism as prepared in part by them. These circulars contain many statements about hypnotism and about the advantages to be derived from its study and practice which are not justified by the articles written by the undersigned, which in their judgment cannot be substantiated by any facts known to science, and which they believe to be in the highest degree misleading. Furthermore, the undersigned are of the opinion that the practice of hypnotism by the general public is attended by dangers which have no compensating advantages, and would in no case countenance any scheme which encourages its practice under such conditions. They feel it incumbent upon them, therefore, to make a public statement of the circumstances under which these articles were written.

Each of them was requested, individually, by 'The New York State Publishing Company,' of Rochester N. Y., to prepare an article for a collection of such articles. Inquiries made of this Company elicited no suggestion that the collection was to be issued by any other than the usual method of publication and sale, and the articles were contributed by the undersigned without their having any knowledge or suspicion that they would be used as constituent parts of a course of instruction in hypnotism. Had they known that they would be so used, they would have refused to contribute the articles in question. They now disclaim all responsibility for the methods adopted by the American College of Sciences and for all statements made in its publications, excepting only those found in the several articles above referred to, and for them their individual authors are alone responsible.

While the position of the undersigned on these questions is perhaps already sufficiently well known to the academic world, they feel that this disclaimer is due to the general public.

J. MARK BALDWIN, Princeton University.
W. P. CARR, Columbian University.
E. W. SCRIPTURE, Yale University.
J. W. SLAUGHTER, University of Michigan.
ALFRED REGINALD ALLEN, Philadelphia Polyclinic Hospital.
GABRIEL CAMPBELL, Dartmouth College.
ARTHUR MACDONALD, U. S. Bureau of Education.
JAMES H. LEUBA, Bryn Mawr College.
ROBERT M. YERKES, Harvard University.
CLARK WISSLER, Columbia University.
ERNEST CARROLL MOORE, University of California.
EDWARD H. ELDRIDGE, Temple College.
WILLIAM ROMAINE NEWBOLD, University of Pennsylvania.

CURRENT NOTES ON METEOROLOGY.

A RECENT STUDY OF ECLIPSE METEOROLOGY.

'A DISCUSSION on the Observations recorded during the Solar Eclipse of January 22, 1898, at 154 Meteorological Stations in India' is the title of Vol. XI, Part II, of the Indian Meteorological Memoirs (Calcutta, 1900). This is a report by Mr. John Eliot, Meteorological Reporter to the Government of India, consisting of 66 pages of text and tables, together with 38 plates showing curves of temperature, pressure, cloudiness, humidity, etc., at different stations. In these plates the actual and probable curves of the diurnal variation of the different weather elements are given for a large number of stations, so that the effects produced by the eclipse can easily be seen. A brief summary of results gives in a very condensed form the most important points brought out in Mr. Eliot's study.

The total reduction of air temperature accompanying and due to the eclipse varied directly as the amount of the greatest obscuration of the sun, and also to a slight extent with local conditions and peculiarities of air movement. The *average* maximum reduction near the belt of totality in the interior of India was 8°. The maximum reduction of temperature appears to have occurred at Karwar (12°), and at Sahdol (10°). The time of the greatest diminution of temperature followed the time of greatest obscuration of the sun by an average interval of 23 minutes. The pressure observations indicate that there was a steady increase of pressure during the first stage of the eclipse, of little or no resulting variation during the second stage, and of increase after the termination of the eclipse at a smaller rate than during the first stage, and also at a decreasing rate. The air movement fell off very rapidly during the first stage (that of decreasing heat and light), and was feeble during the greater part of the second stage. One of the most noteworthy meteorological features of the eclipse was a short sudden gust which occurred about twenty minutes after the commencement of the eclipse at a majority of stations in and near the belt of totality. There was a large and rapid increase of the vapor pressure and also of the relative humidity, followed by an equally large and rapid decrease, the whole constituting an oscillatory variation of large amplitude and very short period.

NATIONAL GEOGRAPHIC MAGAZINE.

THE *National Geographic Magazine* for November contains three articles of meteorological interest. The first is an account of 'The Manila Observatory,' by Father José Algué, S. J. This observatory has done excellent work, especially in connection with the typhoons of the Far East. Frequent reference has been made to the publications of the Manila Observatory in these Notes. The second paper is by Mr. F. H. Newell, of the U. S. Geological Survey, and deals with *The Limited Water Supply of the Arid Region.* The land west of the 100th meridian was, as Mr. Newell points out, at first thought to be worthless for agricultural purposes. Then the pendulum swung far in the other direction, and the general feeling was that there was abundant water for irrigation and that all the land could be utilized. Finally we have reached the present stage, when the limits of the water supply are coming to be fairly well seen, 'and the statement that only five or ten per cent. of the land can be reclaimed excites comparatively little interest.' The third paper of meteorological importance is one by Gen. A. W. Greely, entitled 'Hurricanes on the Coast of Texas,' in which an account is given of the hurricane of September 15–16, 1875, 'which caused a relatively greater loss of life and property to the town of Indianola, Texas, than was inflicted on Galveston by the recent hurricane.'

THE CAPE HORN PASSAGE.

THE November *Pilot Chart of the North Pacific Ocean* presents a brief but interesting discussion of the passage for sailing vessels around Cape Horn to the westward. This discussion is based on the reports received from 22 vessels which rounded Cape Horn from east to west during 1899, and brings out in a very striking manner the direct control exercised over the sailing routes around Cape Horn by even the temporary winds of a cyclonic depression. It appears that the most favorable weather condition for the passage is the presence, during the period necessary for rounding Cape Horn and for crossing latitude 50°S. in the Pacific, of a center of low pressure in the immediate vicinity of the Cape, and not too far to the southward. This distribution of pressure gives N.E., E. and S.E. winds in succession in the case of a westbound vessel which keeps this center constantly on the starboard side, *i. e.*; which passes the center to the southward. One of the fastest passages made around Cape Horn in 1899, that of the British bark *Inveramsay*, was made under these conditions.

UNDERGROUND TEMPERATURES DURING A HOT WAVE IN SOUTH AUSTRALIA.

IN his report on the *Rainfall in South Australia and the Northern Territory during 1897*, Sir Charles Todd, Government astronomer of South Australia, calls attention to an interesting case of slow penetration into the ground of the high temperatures of a hot wave. During

February, 1897, there occurred a long spell of hot weather, lasting from the 7th to the 18th with maximum temperatures between 82.6° on the 7th and 107.3° on the 10th, or over 100° on five days and over 90° on ten consecutive days. On the morning of February 8th the temperature at the Adelaide Observatory at three feet below the surface was 71.5°; at five feet, 68.6°; and at eight feet, 67.5°. On the morning of the 18th the readings were 73.6°; 69.3° and 68.4° respectively, showing a gradual increase during the intervening period, the increase being 2.1° in the ten days at three feet, 0.7° at five feet and 0.9° at eight feet. These observations show clearly 'that it requires a very long continuance of heat to materially affect the thermometers ten feet only below the surface.'

R. DeC. Ward.

BOTANICAL NOTES.

THE POWDERY MILDEWS.

A notable contribution to the literature of fungology has appeared in Mr. Ernest S. Salmon's 'Monograph of the Erysiphaceæ,' published as Volume XI. of the Memoirs of the Torrey Botanical Club. It constitutes a thick octavo pamphlet of nearly three hundred pages, and nine plates of one hundred and seventy-five figures. The paper opens with a couple of pages of remarks on the limits of the family, eight or nine pages on morphology and life history, a few pages devoted to the history of the study of the group, the connection between host and parasite, and distribution of the species. The family is restricted to the six genera *Sphaerotheca*, *Podosphaera*, *Uncinula*, *Microsphaera*, *Erysiphe* and *Phyllactinia*. All the known species in the world are included, and it speaks well for the conservatism of the author that although he examined the material in the most important collections in Europe and America, he has found it necessary to describe but two new species and two new varieties. Such conservatism and self-denial are most commendable and encouraging, and may well serve as a model for other monographers, who too often find new species every time they turn over their material.

So conservative has been the writer of this monograph that under his treatment the grea number of specific names in the family is reduced to but sixty species and varieties. Thus, while *Erysiphe* has had one hundred and sixty-five species and varietal names associated with it, there are here but nine; so the fifty-eight names under *Microsphaera*, are reduced to nineteen; the twenty-four under *Podosphaera* to five; the twenty-one under *Sphaerotheca* to six; the thirty-eight under *Uncinula*, to twenty; and the nine under *Phyllactinia*, to one. Of course it is not to be supposed that Mr. Salmon made all these reductions; to a large extent they had been made already by other students of the family, but it is greatly to his credit that with such an opportunity he did not give us a greatly increased list.

According to this monograph the accepted names of some of the more common of the Powdery Mildews are as follows: Cherry Mildew, *Podosphaera oxycanthae;* Rose Mildew, *Sphaerotheca pannosa;* Gooseberry Mildew, *Sphaerotheca mors-uvæ;* Willow Mildew, *Uncinula salicis;* Grape Mildew, *Uncinula necator;* Lilac Mildew, *Microsphæra alni;* Pea Mildew, *Erysiphe polygoni;* Sunflower Mildew, *Erysiphe cichoracearum.*

PLANT BREEDING.

From a paper by H. J. Webber and E. A. Bessey on 'The Progress of Plant Breeding in the United States,' recently published in the Year-book of the Department of Agriculture, the scientific botanist may learn much which may well surprise him as to what has been accomplished in the work of plant breeding. That man can bring about definite results by the careful breeding of animals is more or less well known, but that plants may be bred with as definite an object in view, and as successfully, is not yet a matter of common knowledge.

It is only during the latter half of the present century that much progress has been made in plant breeding proper, the earlier efforts at the improvement of plants having been through the selection of seeds of the most desirable plants for further cultivation. Downing, Hovey, Wilder and some other far-seeing horticulturists of the earlier days continually urged the breeding ('crossing') of the better varieties of fruits

in order to combine the qualities and characteristics of the kinds so treated. This advice eventually bore fruit, and to-day the florist plans to bring about a definite result by securing offspring from the union of two plants, whose form, color, odor or other qualities he may wish to intensify or modify. Among fruits the grape, raspberry and strawberry have been much modified by careful breeding. The tomato illustrates what may be done by the skillful breeder, as practically all the improvement which it has undergone is due to carefully planned hybridization, followed by as careful selection. In like manner the cereals, maize and wheat, have been improved in recent years by the crossing of selected varieties.

THE BUTTERCUP FAMILY.

UNDER the title 'A Taxonomic Study of North American Ranunculaceæ,' Dr. C. K. Davis, of the State Normal School, St. Cloud, Minn., publishes a privately printed pamphlet of one hundred and seventy-three octavo pages describing the genera and species of the North American Ranunculaceae, native and introduced. The studies (entirely taxonomic) on which the pamphlet is based were made in Cornell University, where the author had access to the admirable collection of cultivated plants known as 'Cornell Garden Herbarium,' as well as of materials and books in the National Herbarium, the Herbarium of the New York Botanical Garden, and the Gray Herbarium of Harvard University. The result is an arrangement of the family differing considerably from that of either Bentham and Hooker in their 'Genera Plantarum,' or of Prantl in Engler and Prantl's 'Natürlichen Pflanzenfamilien,' although much more like the latter than the former. Dr. Davis proposes to divide the family (which for some reason not given he calls an 'order') into five tribes, which he arranges in the following sequence: I. *Crossosomeae;* II. *Pæonieae;* III. *Helleboreae;* IV. *Clematideae;* V. *Anemoneae.* The genus *Crossosoma* of Nuttall, referred by Bentham and Hooker to the Dilleniaceae, and by Engler and Prantl made the type of a separate family, Crossosomataceæ, is here included in the Ranunculaceæ. The two species and one variety occur in Southern California, Arizona, and Northern Mexico. In the *Helleboreae* the name *Cammarum* of Hill (*Brit. Herb.*, 1756) is substituted for Salisbury's name, *Eranthis* (1807), in accordance with the suggestion made by Professor Greene in *Pittonia*, April, 1897.

The work is quite uneven, some portions (notably those first published in the 'Minnesota Botanical Studies') being much more scientifically treated than others which were first printed in horticultural magazines. The pages falling under the latter category are printed in different type, often in poor type, marring the appearance of the book, and giving it a 'patchwork' appearance. However, in spite of its unfortunate printing it is worthy of a place in the library of every working botanist.

RED CEDAR DISEASES.

DR. VON SCKRENK, of the Shaw School of Botany and Special Agent of the Division of Vegetable Physiology and Pathology of the United States Department of Agriculture, describes (in Bulletin 21, of the Division) two fungi which produce diseases of the wood of the Red Cedar (*Juniperus virginiana*), known respectively as 'white rot' and 'red rot.' The first ultimately causes long holes, lined with the brilliant white remains of the decayed tissues, to appear in the wood at intervals of a few inches. This disease is found to be due to a species of *Polyporus* (Fomes) related to, if not identical with, *P. fomentarius*, and for which the author proposes the name *P. juniperinus*. It occurs in Kentucky and Tennessee. The 'red rot' is said to be more common than the preceding, and is more widely distributed, occurring in Missouri, Arkansas, Kentucky, Tennessee, Virginia and New York. It produces large holes in the wood, but these are brown within, and are lined with the brown, cubically cracked remains of the decayed wood. This is found to be due to another species of *Polyporus*, viz., *P. carneus*, a small, woody, flesh-colored polypore, which grows in the holes at the bases of the fallen branches. A number of photographs, excellently reproduced, illustrate this valuable paper.

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